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THE VOYAGE OF THE DEWEY.

By LIEUT.-COMMANDER F. M. BENNETT, U. S. Navy.

It was the intention of the writer to make this narrative simply a plain tale of the sea, describing mishaps, accidents and obstacles met with and expedients resorted to by the naval expedition that transferred the floating dry dock Dewey from Chesapeake Bay to the Philippine Islands. In putting the numerous events and incidents of the voyage together it appears that some account of the preparation and equipment of the expedition is necessary to save many explanations as the story progresses, and a few paragraphs will therefore be devoted to the fitting out before the actual seafaring begins.

The floating dock itself needs little description in these pages. It has been widely described and pictured in naval and technical journals and by the press at large, so it may be assumed that anyone sufficiently interested in the subject to read this article already knows what sort of structure we had to deal with. In a very general way, then it is only necessary to say that the dock is a rectangular box 500 feet long, 135 feet wide, and 18 feet deep, with side walls 14 feet thick and 45 feet high extending along almost the whole length of the longer sides. Viewed from a

short distance, these high and narrow brown-painted side structures look remarkably like the breakers about the mouth of a coal mine or the grain elevators in the towns of the middle West and suggest not at all any form of known sea-going craft. The industrial expression of the whole fabric is added to by four tall sheet iron smoke pipes of the kind used on saw mills projecting from the tops of the side walls high into the air.

When equipped in all respects for sea the dock's weight, or in other words its displacement, was about 12,000 tons and its draft somewhat less than eight feet. Floating so lightly, more than ten feet of the main hull or pontoons extended above water which, with the side walls, made a sheer blank surface 55 feet high and 500 feet long upon which the wind might act to our disadvantage. In even the lightest breeze, unless dead ahead, the dock would trail off to leeward far from the course, while a moderate or fresh breeze abeam would set it over thirty degrees or more and seriously interfere with its steady towing. Even in a calm or a head wind we found that it would not tow straight but would yaw at intervals from one side to the other as a kite does in the air. With the wind anywhere forward of the beam the tendency of the dock was to head into the wind, which was natural, as the forward end was restrained by the towing bridle while the after end was free to drift off before the wind.

To offset to some extent the tendency of the dock to drift to leeward it was customary to let water into its ballast compartments. This reduced but slightly the area exposed to the wind, but the most important result was in adding greatly to the dead weight that the wind had to push through the water. Without engaging in any very refined mathematical calculations we found about 1500 tons of water would sink the dock one foot, and 6000 tons would increase the draft four feet. This method of adding to the weight and draft of the dock was always resorted to in high winds and heavy seas and was of great value in enabling it to resist both, the impact of the seas especially. The amount of water admitted varied with the weather from one to four feet, the latter being the prescription for a strong gale. This great addition to the weight of the dock of course made towing more difficult, but when water ballast was used the situation was generally such that the question of making progress on the course was one of secondary consideration.

The dock was never sunk enough to bring the pontoon deck awash, which would have required the admission of about ten feet of water, or 15,000 tons, and the subsequent obligation to pump it out. When the expedition was fitting out in the United States various newspapers freely spread abroad information as to how the dock ought to be handled in bad weather. One article that I remember stated in all seriousness that in a gale the dock would be submerged thirty feet and the towing vessels would then snugly moor themselves inside, there to lie in comfort and quiet until fair weather! The experiment was not tried: in fact it was quickly learned that proximity to the dock, even in moderate weather, was undesirable. A little experimenting was done in changing the trim of the dock so it would have a different draft at the ends, but no noticeable results followed, notwithstanding the well-known advantage gained in towing a log by the big (or the little?) end, so well established by a steerage argument of great antiquity.

The greatest obstacle to towing that we encountered was in the structure of the dock itself in presenting a perfectly square wall-like surface to be dragged through the water and against head seas. Inasmuch as the law authorizing its construction specified that it was for use in the Philippine Islands, 12,000 miles from where it was built, it is strange that the design was not influenced by the knowledge that such a long voyage would be the first event in its history. Similar floating docks have been built with V-shaped or rounded ends to facilitate towing, and others have been taken to sea provided with false bows for the same purpose. Had this dock been fitted with sea-going ends or bows I may say with absolute certainty that the voyage to the Philippines would have been accomplished in two months less time and with much less risk of losing the dock; that thousands of dollars worth of towing gear destroyed by hard service would never have been used; that many more thousands of dollars worth of coal would not have been burned, and that the officers and men of the towing squadron would have been spared much anxiety, physical hardship, and, at times, actual peril. This, at least, is my belief after having seen the square-ended obstinate structure dragged by main strength, through fair weather and foul, across one hundred and ninety-seven degrees of the earth's longitude.

About the middle of October, 1905, it was decided to start the dry dock for the Philippines, via the Suez Canal, as soon as possible. A previous study of wind and weather conditions in different parts of the globe at different seasons of the year, made by officers on duty in the Navy Department, had resulted in the conclusion that the expedition should leave the United States early in December at the latest in order to have the best chances for good weather along the Suez route. It was already too late in the season by two months or more for the route by way of the Cape of Good Hope to be attempted, though it had been considered earlier. The orders eventually issued to the commander of the expedition did not specifically bind him to pursue any particular route, but directed him to deliver the dock to the commandant at the Cavite naval station, the manner of getting it there being left entirely to his good judgment.

The naval supply ship *Glacier* and the colliers *Brutus* and *Cæsar* were designated as the towing ships and the work of fitting them for that service was taken in hand at the Boston and Norfolk navy yards. Some time later the naval tug *Potomac* was detailed for the expedition, but as she is a tug pure and simple little or no preparation had to be made in her case. The principal work on the large ships consisted in installing towing machines and in removing from the after part of the upper decks all rails, stanchions, boat davits and other fittings that would interfere with the free scope of towing lines. On board the *Glacier* at the Boston navy yard three large steel arches or towing frames were erected across the after deck to hold the towline up clear of the hand steering gear and over two small deck houses. These arches were capped with solid oak timbers a foot square and as hard as bone, being old ship material that had been seasoning for years, but in use we found that the steel towing hawser in working back and forth would bite into them like a saw and tear out big chunks of the tough fibre with every lateral movement. Later, at the New York navy yard, the largest of these arches was reinforced with more oak covering and two heavy king posts, stepped on deck, were secured to it with steel bands, their object being to limit the athwartship travel of the tow-line. These towing frames were very clumsy and inconvenient, and they were not necessary, since the *Brutus* and *Cæsar* were made fit for their work without them. On those

vessels the towing machines were placed higher than on the *Glacier* and the hand steering gears were protected by timber casemates built over them. In consequence they had better control of their hawsers and a clearer space in which to handle them than we had on board the *Glacier*.

The towing engines for all three ships were supplied by the American Ship Windlass Company, of Providence, Rhode Island, and were the largest size (designated as No. 5) that the makers could deliver within the limited time allowed. Larger ones would have had to be made especially for the expedition, and it is unfortunate that time did not permit such manufacture. The ones we had were ponderous enough to look at and were of the size that had proved sufficient for the heavy tows of barges that one sees along the Atlantic coast of the United States, but they were not able to hold a 12,000-ton dock up against the weather of the Atlantic ocean in mid-winter. When only 500 miles off shore at the start the towing engine on the *Cæsar* was disabled by teeth breaking out of the drum gear, and three weeks later in a gale in mid-ocean the one on the *Brutus* was literally torn to pieces and the dock set adrift by the tow-line going overboard. All three ships and the dock were provided with wireless telegraph outfits, electric searchlights and night signalling apparatus, all three installations essential to the work in prospect, and the wireless telegraph so much so that on some occasions confusion and possible disaster would have resulted but for the quick interchange of information by its means.

The selection of low-powered steamers for such a large undertaking may be questioned, but when the most desirable requisites are considered it must appear that the ships employed were more suitable than high-powered cruisers or battleships could have been. Ability to carry coal for long periods at sea practically limited the choice to colliers, the coal problem in the case of the *Glacier* being met by putting 2000 tons into her holds and refrigerator spaces. The latter vessel was selected of course because of her cold storage outfit which enabled her to carry fresh provisions in ample quantity for all the vessels in the expedition. When towing under favorable conditions, the *Glacier* of 7000 tons displacement developed from 1700 to 2000 horse-power; the *Cæsar*, of 5000 tons, developed about 1200, and the *Brutus*, displacing 6600 tons, developed only about 1100 horse-power.

That is, the actual indicated horse-power of the three big steamers was only about 4000 altogether, which had to be applied to keeping their own weights, aggregating nearly 19,000 tons, in motion before any of it could be felt by the dock. At a glance it would seem that a single cruiser of 6000 or 8000 tons displacement capable of exerting 6000 or 8000 horse-power would have been better than all three of the towing ships combined. But aside from the question of prolonged coal and food supplies there are objections to such a rapid conclusion.

One objection is that the inertia of the heavy masses of the three ships moving uniformly, though slowly, served as a protection to the tow-lines against sudden jerks to which they would have been subjected by a light high-powered cruiser in rough weather. Another is that there is a sufficient element of danger in being shackled to an object like a dry dock in stormy unfrequented seas to make it desirable to have more than one ship present. Yet another objection lies in the fact that at one time or another we broke nearly every unit in the towing outfit at least once, showing that any increase of power would have only added to the troubles of the expedition. Any increase of speed would have been resisted in such a multiplying ratio by the square-fronted dock that abnormal power and great increase in dimensions (and cost) of towing gear would have been necessary to permit of any noticeable increase of speed. All things considered, the ships selected for the undertaking were as suitable as any that our navy list affords. The only really serious defect they had was that they were all single-screw vessels. When it was necessary, as it was many times, to take the dock and each other in tow in rough water and high winds at sea, much time and labor was lost and positive danger sometimes incurred because of the lack of handiness of these big and clumsy single-screw ships.

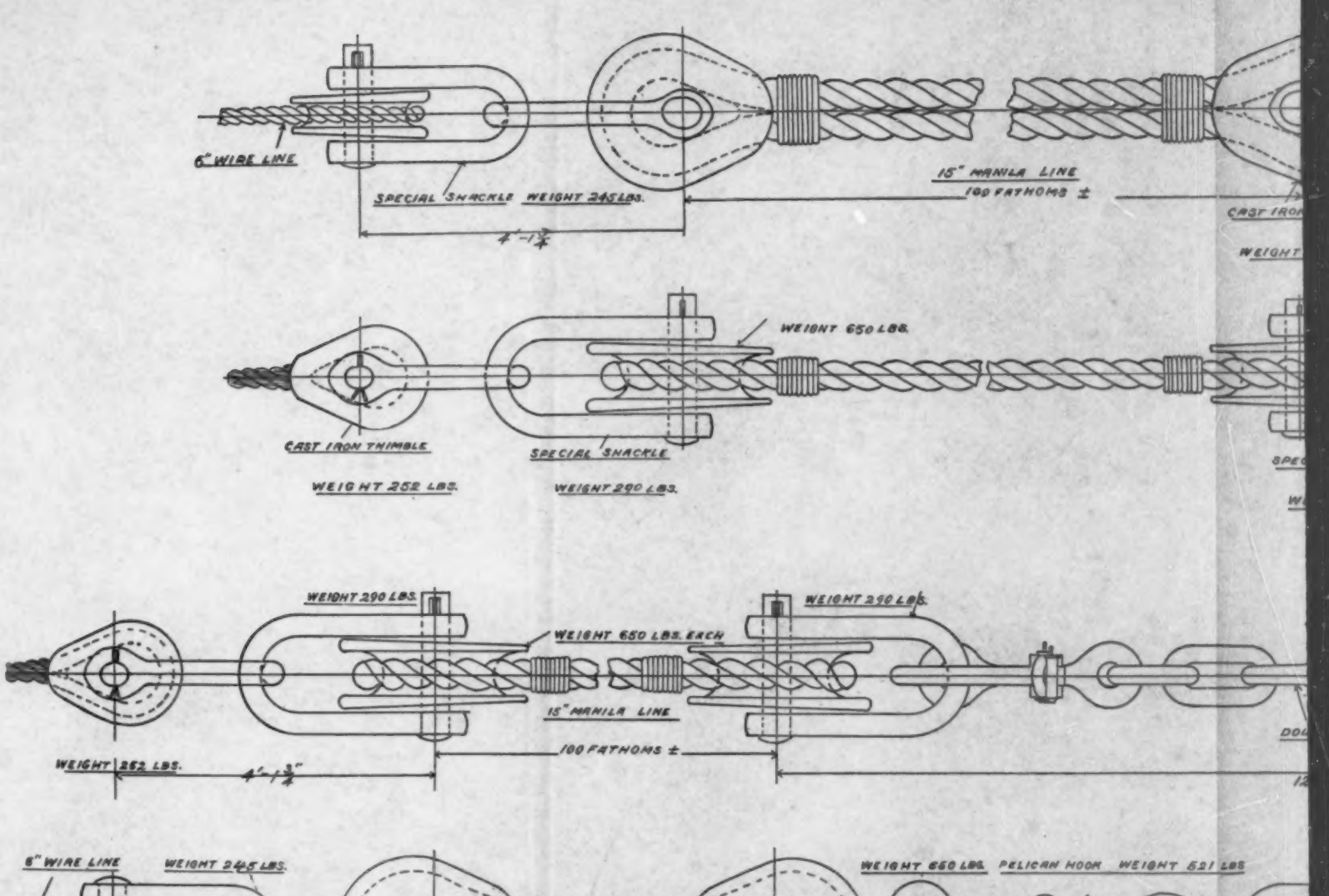
Commander W. F. Fullam, of the *Glacier*, was selected as commander of the expedition late in October, and that energetic officer went immediately to the Patuxent river, where the dock was moored, to see what would be necessary to prepare it for sea. He found that everything in the line of preparation had yet to be done. Aside from the fact that the dock was afloat it was as unfit for sea as a newly finished storehouse in a navy-yard might be. There was not a fathom of chain or hawser for tow-

ing it, either on the dock or provided elsewhere: no working anchors, no chain cables for anchors, no capstan for handling anchors, no appliances for handling towing lines, "no nothing," literally. On the whole expanse of the great pontoon deck there was not a solitary ring bolt or link plate for stoppering chains or hooking leading blocks! The dock was moored with mushroom anchors at the corners but there was no provision for getting them in on deck in case of getting underway, no hawse pipes nor billboards onto which they could be hove for safe transportation. It is needless to enumerate here all that was found lacking at this inspection, but the thoroughness of Commander Fullam's report deserves mention as well as the foresight shown by him as to what would be needed on such an unusual voyage. He specified not only the number and size of towing hawsers required but also the quantity of spun yarn that should be provided. In all things, great and small, the report was complete, and insistent in tone as to the genuine need for everything asked for. Among the important things asked for were, of course, such essentials as anchors and chains, a steam capstan, towing bitts, chain bridles, and life boats, but such lesser items as coaling trucks, rigger's tools, deck stoppers and heaving lines were not overlooked.

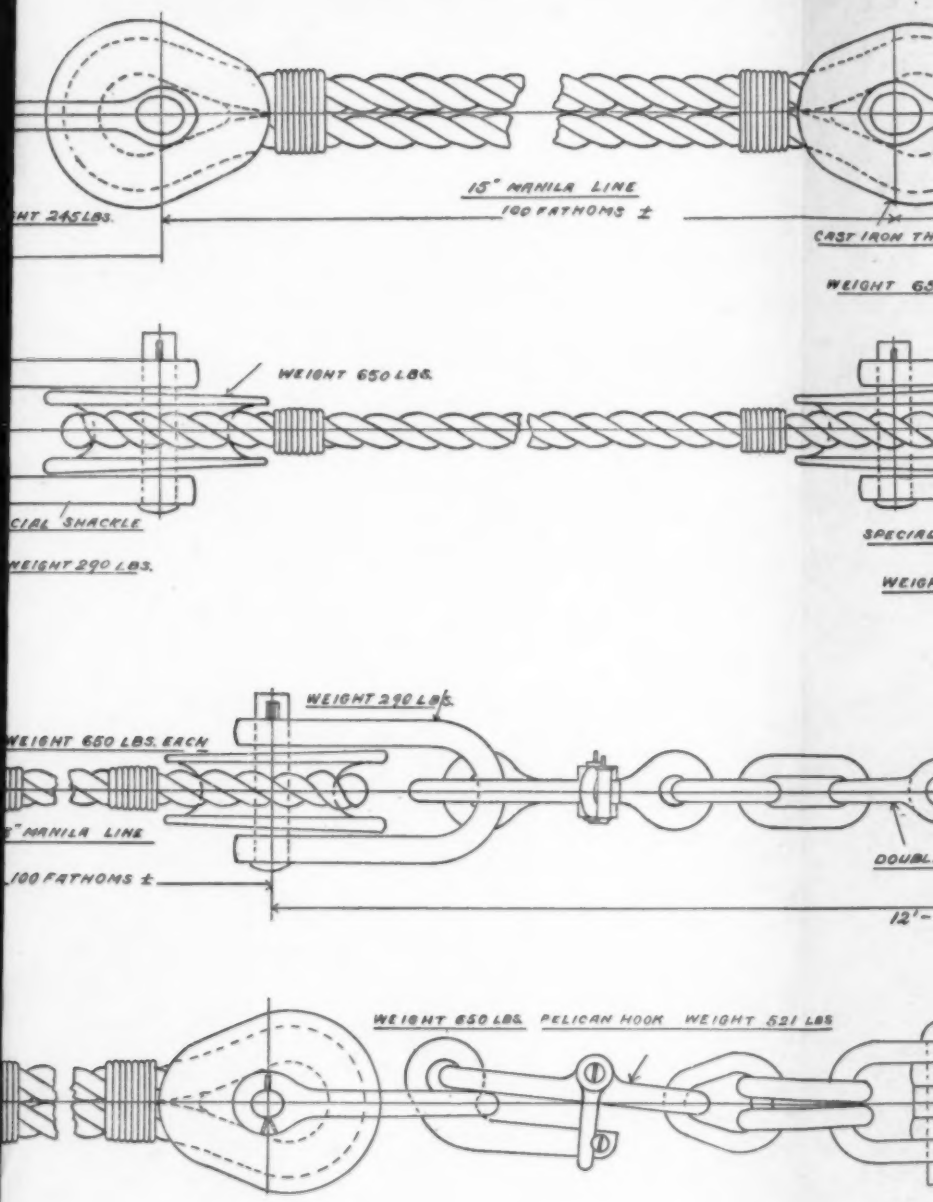
It had now become the first of November, and the receipt of this report at the Navy Department set in motion much manufacture and preparation at widely separated points, each Bureau interested turning to with a will to hasten forward its own share of the work. The equipment shops at the Boston navy yard undertook the manufacture of a quantity of huge towing thimbles for 15-inch manila and 6-inch wire lines, with shackles, swivels and pelican hooks to go with them. Swivels weighing half a ton and shackles, thimbles and pelican hooks weighing a quarter of a ton each are unusual, but they were provided for this expedition and were none too heavy, as some of them were broken in use. The same Bureau from its Boston department provided four 9000-pound Dunn anchors and 480 fathoms of 2¼-inch chain for them, 360 fathoms of 2½-inch chain for towing bridles, a great quantity of manila cordage, and many others items. A fine steam capstan was found by taking one from the armored cruiser *New York*, then laid up for repairs at Boston. The Wall Rope Works undertook the manufacture of twelve 15-inch ma-

nila hawsers, each 1200 feet long, and the Roebling Bridge Works agreed to supply four 6-inch steel hawsers, also 200 fathoms long. Twelve of these were required, but the Roebling firm could not promise that number within the short time allowed and eight were ordered by cable from England. As soon as completed these heavy lines were sent to the New York navy yard where, under the supervision of Chief Boatswain William Anderson, they were fitted with the thimbles and shackels from Boston and otherwise prepared for use. Five of the big 15-inch lines were doubled by splicing the ends together and a towing thimble was secured in the bight at each end, the two parts being seized together to prevent cable-laying by stout lashings every two fathoms along the whole length. As thus made up, each one constituted a towing span weighing six tons which was an ugly object to run as a tow line and a worse one to haul back on board ship after it had been a month or more in the water. The steel hawsers were fitted with a thimble and shackle in one end, the other end being left free for clamping to the drum of the towing machine; they weighed about 7000 pounds each. The plate accompanying this article shows the details of all these fittings, but the order in which the various parts are assembled in the drawing is not meant to show the actual arrangement in use. At the New York navy yard also was provided a great quantity of other gear for the expedition—bale fenders, chafing mats, hook ropes, deck tackles, snatch blocks, oil bags, chain and manila straps, bull ropes, cork buoys for running messenger lines, etc., etc.

The Bureau of Yards and Docks set a force of men at work on the dock in the Patuxent river, building chain lockers, fitting link plates to the deck, installing the steam capstan, fitting boat davits, and remedying other deficiencies. In compliance with an urgent recommendation of Commander Fullam a wooden trestle-work bridge was built across one end of the dock to afford means for handling bridles and tow lines. There was a steel swinging bridge at the other end of the dock to which purchases could be hooked for handling the towing gear and other heavy weights, but it was plainly essential that both ends of the dock be so fitted. By keeping a bridle and towing span shackled together and ranged on the deck ready for use at the rear end of the dock much time and labor was saved after the dock had



TOWING DEVICE FOR U. S. DRY-DOCK DEWEY.



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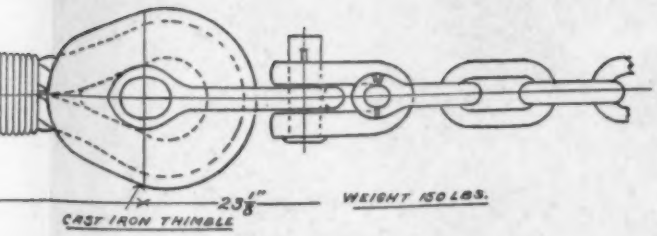
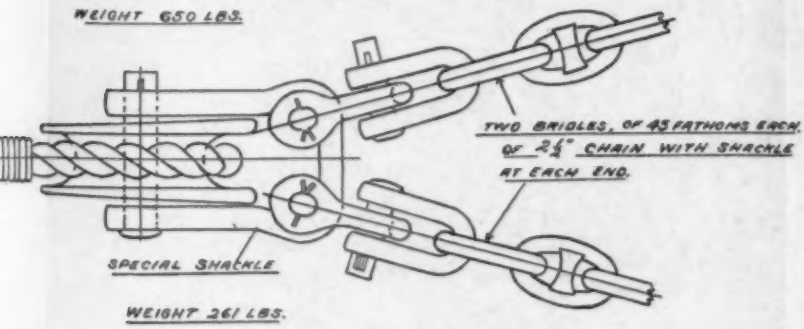
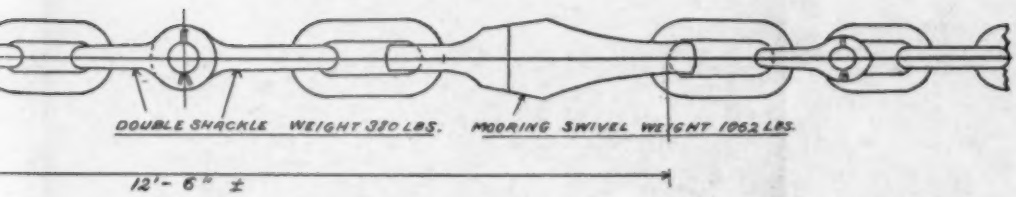
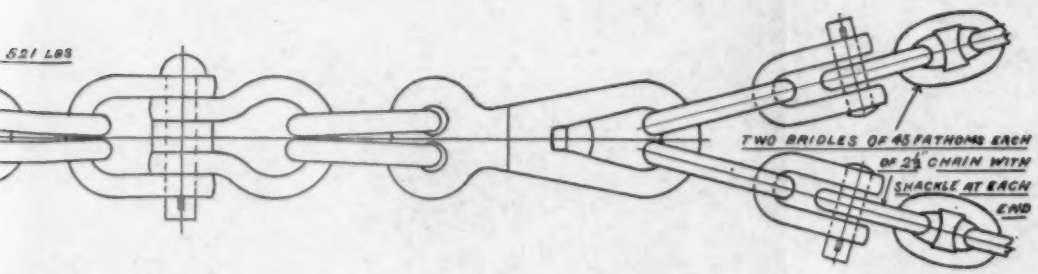
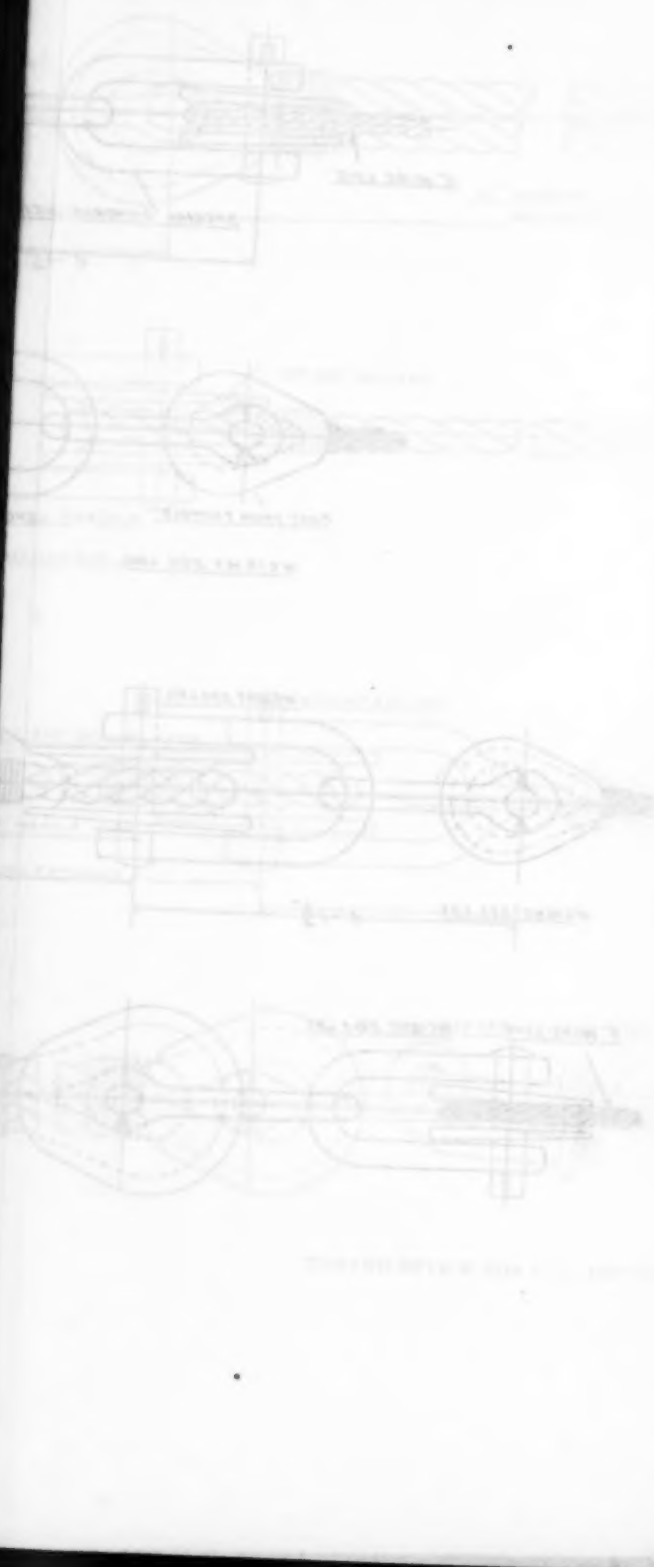

23 1/8"
CAST IRON THIMBLE
WEIGHT 150 LBS.


WEIGHT 650 LBS.
TWO BRIDLES, OF 45 FATHOMS EACH OF 2 1/2" CHAIN WITH SHACKLE AT EACH END.
SPECIAL SHACKLE
WEIGHT 261 LBS.


DOUBLE SHACKLE WEIGHT 330 LBS.
MOORING SWIVEL WEIGHT 1062 LBS.
12'- 6" ±


521 LBS
TWO BRIDLES OF 45 FATHOMS EACH OF 2 1/2" CHAIN WITH SHACKLE AT EACH END

VEY.



been adrift, as towing could be resumed from that end, leaving the damages at the other end to be repaired at leisure. This belated completion of the dock was badly handicapped by being done at an inclement season of the year and at a point remote from supplies, where material and tools had to be brought from a distance, and where it was difficult to induce workmen to remain because there was no place for them to live except such as could be found in a peculiarly forlorn and squalid village. The result was that the work was much protracted and days were lost that would have been worth twice their length could they have been used in towing the dock at sea. There were some provoking delays in fitting out the ships, but in the end the towing ships were assembled in the Patuxent equipped and ready for work ten days before the dock was ready.

Something may now be said about the personnel of the expedition. The colliers had what are officially designated as "merchant officers and crews." The masters, mates and engineers were Americans, probably above the average of the competent self-reliant type so usual in our merchant marine. The crews were Chinese, a relic of former service in the Asiatic fleet, and were satisfactory, the men being well-behaved, industrious, and capable of doing their work well on deck and in the fire rooms. They knew no English and therefore there was no one on deck at night capable of reading or sending a signal except the officer in charge of the watch. This was a very disquieting situation, for in case of accident that individual would in all likelihood have to give his time to assuring the safety of his own ship, without any opportunity to warn others by signal. As a simple matter of safety English-speaking quartermasters or signalmen should have been assigned to those ships.

The *Glacier* had a regular naval crew, the usual run of men available on the receiving ships, and not selected in any way for this special service. If anything, this crew was somewhat below the average of a man-of-war crew in morale, the ship having been commissioned in Boston. The original crew was insufficient in numbers for the work of the ship, and upon the urgent recommendations of the commanding officer additions were granted until we finally left the United States with fifteen men in excess of complement. This being still inadequate, further additions were subsequently made by taking men from the *Tacoma* in the

Mediterranean sea. The seaman branch of this crew was sadly deficient in experience, as it was composed almost entirely of mere boys, just rated ordinary seamen, enlisted only a short time, with no sea service, and no naval experience except at the Newport training station. They were willing and intelligent, but with every day devoted to stevedores labor there was no opportunity to teach them how to become handy about a ship. Their inexperience was particularly trying in the matter of a life boat's crew at sea, it being often necessary to communicate by boat with other vessels or the dock, and in rough weather it was really perilous to lower a boat manned by these boys. I am aware of the desirability of keeping experienced men in the fighting ships, but in view of the service ahead of the *Glacier* it seems that one good seaman might have been taken from each of a dozen ships of the Atlantic fleet without impairing their efficiency and a capable life boat's crew in each watch thus provided for us.

The dock was manned by a composite crew, or rather by two crews, an arrangement not conducive to harmony or best endeavor. One consisted of a temporary crew shipped for the voyage, twenty-two men in all, including the sailing master and the two mates. The other nine men all told, including a dockmaster, was the permanent force of the Bureau of Construction and Repair, to remain with the dock after reaching its destination to attend to its maintenance and operation. The temporary crew comprised a rigger, whose services were found invaluable, a wireless telegraph operator, a "dock expert" at $300.00 per month, twelve seamen, cook, steward, and two messmen. The dock expert had been a superintendent or foreman with the company that built the dock and was so familiar with its fittings that he was a useful person to have on board. He became dissatisfied notwithstanding his high rate of pay, and resigned when we reached Port Said.

Of the seamen I cannot speak with enthusiasm. They were of the kind referred to in sea stories as deep water sailors and appear as interesting and even heroic characters in those works of fiction, but masters and mates whose opportunities for knowing them excel those of the sea writers do not hold them in great esteem. In the sea tales it usually appears that disloyalty to employers and insubordination to officers are reckoned as virtues in the forecastle, and from what I saw and heard of affairs on

the dock it would seem that the men were average specimens of their kind and indulged their proclivities with much more freedom than is permitted by a forceful shipmaster. It is but just to say that at sea, well away from land, they did much excellent and hard work, but the shore seemed fatal to their energies: perhaps this is the reason why they are called deep water sailors. Sailors though they were by trade, they were far more lubberly in boats than were the young ordinary seamen of the *Glacier*, and they could not compare in a life boat with the Chinese crews of the colliers.

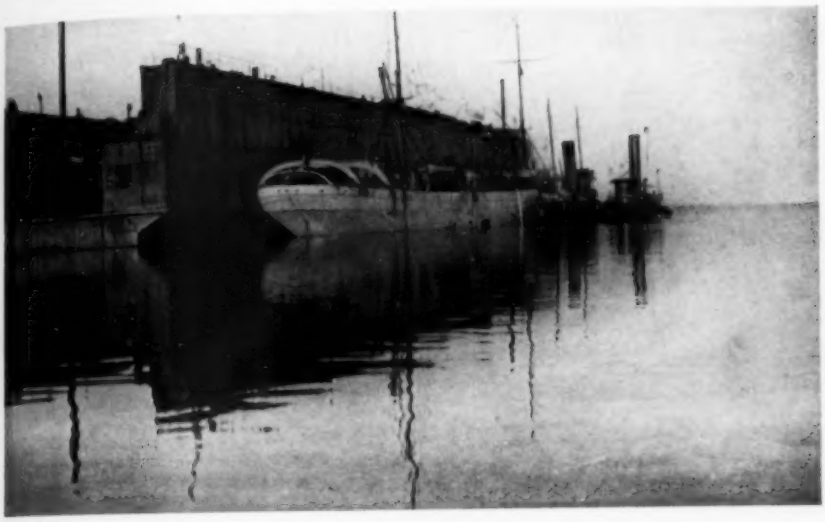
At Las Palmas, the first port where we stopped, these men left the dock half moored to the mole and went ashore almost in a body, remaining as long as they chose, behaving on shore in such manner as to cast discredit upon the expedition, and, in general, showed total disregard for the obligations they were under. Working parties from the towing ships had to go on board the dock to moor it properly and laborers from shore were actually hired to do the work of the crew while in that port. The sailing master appeared incapable of exercising any control over his men and the commander of the expedition could not legally discipline them because they were merchant seamen, shipped under the navigation laws, and entitled to a hearing before a United States Consul. Several of them deserted or were discharged at that port and their places filled by shipping new men. At that port also, authority was received from the Navy Department to add six seamen to the complement of the dock, the original allowance having been found insufficient. The new men taken on were mostly natives (Spaniards), and the dock proceeded toward a late Spanish colony with a crew that might, if inspired by patriotic fanaticism, have been disposed to scuttle it rather than see it become a feature of a naval station that so recently had been Spain's.

The work of preparing the *Glacier* for the expedition was somewhat hampered at Boston by rains and cold weather peculiar to the advanced season and was not completed until the night of December 2. She left the navy yard the next day in a driving storm of sleet and rain, felt her way around the Nantucket shoals with the sounding machine, and arrived at the New York navy yard the afternoon of December 5. All the towing gear and supplies that had been collected there were ready for delivery:

too ready in fact, for while our small crew was still on the wharf making fast the mooring lines a train of railway cars piled high with the 15-inch manila hawsers was backed down alongside the ship and a message delivered to the effect that the hawsers must all be stowed on board before sunset. With the force available we could with equal ease have taken down the Brooklyn bridge and stowed that in the hold within the same time limit. A week followed that is easily remembered. Railway cars, coal and provision barges, trucks, wagons, carts and boats, clustered about the ship with cordage and gear of all description, coal, frozen meat, ice, vegetables, paymaster's stores, everything in the way of stores and supplies for six months for all the vessels of the expedition. Hundreds of men and horses delivering the goods and a working force of less than thirty on the *Glacier* to receive and stow them. As soon as the situation became known to the commandant large working parties were furnished from the receiving ship and from the yard departments and the work of loading the ship went forward rapidly, though uncomfortably because of the cold weather.

Commander H. H. Hosley reported for the command of the *Glacier* and the towing expedition December 11, Commander Fullam having been detached before the ship left Boston. The morning of December 13 we left the navy yard and proceeded to sea, entering the Chesapeake the following afternoon, where we had to anchor about 8 p. m., off Rappahannock Spit, because of very thick weather. Continued on up the bay the next morning in the face of a fierce northeast gale with rain, sleet and snow, arriving in the Patuxent river early in the afternoon. Took the *Potomac* alongside at once and transferred the gear and stores that we had brought for her from New York. She had arrived only an hour before we did, and the *Brutus* and *Cæsar* had been there since the day before. We saw also for the first time, dimly through the driving snow, the enormous bulk of the dry dock, a curious looking object, but one that was to become very familiar before we were done with it.

The next morning at daylight we went alongside the dock, a difficult operation in the high wind prevailing and because there were no suitable fittings on the side of the dock for a vessel to make fast to. The *Cæsar* came to our other side and we began transferring the great mass of material we had brought to both,



THE GLACIER ALONGSIDE THE DEWEY.

TOWING SHIPS AS SEEN FROM THE DEWEY.

the *Brutus* taking the place of the *Cæsar* as soon as the latter had received all her gear. In some respects this was the most dangerous and uncomfortable period in the history of the expedition. A storm of sleet and snow had swept over the region just before and as a result our gear was all wet and everything covered with ice and snow, making the work in hand unusually difficult and cruel. Many of the weights to be handled were very heavy, the reels of wire hawsers, for instance, weighing over three tons and the manila hawsers five tons each. Owing to the slipping of straps and tackles several men received minor injuries and one officer, Boatswain Herbert, had a leg broken and had to be detached from the expedition. Another warrant officer, Boatswain Arthur Smith, was disabled for several days with a damaged jaw, but he was in luck because he very narrowly escaped being killed. The accident in which he was involved was caused by the slipping of an icy boom topping lift around the gipsy head of a winch, letting the boom come down by the run and allowing a steam launch with its crew to drop overboard from a height above the rail. Chief Boatswain Phillip Mullen sustained a fractured rib during this same strenuous period.

Within three days, one of which was Sunday, but not a day of rest, we had everything distributed to the different vessels and then had to go to work on the dock, which was found far from ready for sea. The crews of the *Brutus* and *Cæsar* coaled the dock, a slow and difficult operation requiring several days because of the great height to which the coal had to be hoisted, and the *Glacier's* men were employed in moving a great number of keel and bilge blocks away from the ends of the dock and in disentangling the chain bridles from a confused pile and ranging them ready for use. As soon as the *New York's* capstan was set up, the chains of the four 9000-pound working anchors were stowed into the temporary chain lockers and the anchors pointed ready for letting go. The crew of the dock, before described, was on board at this time but was not at all conspicuous in these busy scenes. Our men did much hard and excellent work at this time amid very uncomfortable surroundings, and it seemed a pity that we had to do this heavy work at such an inclement season, when the dock had been there idle all through the pleasant autumn months.

The question of what lights should be carried by the flotilla

naturally received consideration while other preparations were going forward. Commander Hosley came to this duty from the position of supervisor of the harbor of New York and as such was in touch with the seafaring element of that port, from which, notably the Pilots' Association, he received considerable valuable advice. The seamanship experts at the Naval Academy contributed some more, and he, of course, discussed the matter with the masters of the colliers, who were most directly interested in precautions that would reduce the chances of collision. The decision arrived at after considering all this counsel was the following, issued as a general order to the squadron under date of December 22.

"When engaged in towing at night, the leading vessel will show the three white towing lights and the side lights required by law. All the other vessels including the *Dewey* will show the red lights (two) required by law for a vessel not under control, as well as the side lights required by law. During the day the proper shapes as laid down by law must be shown. All vessels will carry a white light aft so screened as not to be visible forward of the beam, to assist the others in steering. The *Dewey* must also carry such a light. . . . . .

"Vessels will at all times keep the spar decks well lighted as a 'show' to passing vessels; cargo lights at both ends are suggested when practicable."

Further thought led to the conclusion that the lights above specified were not certain of giving passing vessels the correct information as to the nature of our formation and on the principle that the more lights shown without actually violating the law the safer we would be, the order was modified as follows the day that we went to sea.

"When engaged in towing, *all steam vessels* will carry the three vertical white mast head lights and side lights; the *Dewey* will carry side lights and *no* mast head lights. *All vessels* will carry a white light aft so screened as not to be visible forward of either beam. The day shapes will not be carried unless especially ordered."

Later, at sea, when it was observed that the *Dewey* was very dark and that lights at her ends appeared disconnected as though on different vessels a considerable distance apart, she was directed to show several white lights along each side. Carrying lights as

prescribed in the modified order, there was never any confusion or danger of collision, mariners of all nations being active to give us a wide berth.

The colliers and the dock not being allowed the general signal book of the navy, we had to use the international code for all ordinary communication and for the routine reports, such as sick, coal on hand and expended, latitude and longitude, etc. The one-flag signals of the international code for use between vessels towing and being towed were found not applicable to our situation and Commander Hosley prepared and put into use a special one-flag series of about twenty important signals. These were easily memorized by most of the officers having to use them and were very simple and convenient. Some of these, like I—"all right, go ahead," or J—"go ahead, full speed," were regarded with pleasure; others excited a contrary emotion because they meant trouble: V was particularly hateful, signifying "the hawser has carried away." Z meant "man overboard," the same as it does in the regular international code, but fortunately none of us ever had occasion to hoist it. A few special two-flag signals were used to supplement the one-flag series. The flags used were all international letters, but a few navy code flags were used for special purposes, the telegraph flag for instance being used as an order for the wireless operators to stand by for a message. The international code contains five pennants, just enough to provide distinguishing pennants for the vessels of the squadron—C for *Cæsar,* D *Dewey,* F *Glacier,* E *Brutus* and G *Potomac.* C and D were also used in their regular code significations as yes and no. At night letters and numerals were made from the navy code, all the vessels having been supplied with signal cards giving the wig-wag, semaphore and ardois systems of signalling. At the beginning it was sometimes difficult to communicate as quickly as we wished but the officers of all the ships soon became sufficiently proficient for our purposes, though never to a degree that would have made them feel comfortable in the battleship fleet.

December 26 the work of unmooring the dock was begun, an operation that consumed all that day and the greater part of the next. Preliminary to heaving up the mushroom mooring anchors the dock was anchored with 9000-pound Dunn anchors, one at each end. Billboards, or more properly hawse pipes, had been

fitted for the mushroom anchors at one end of the dock and the anchors were hove up into them by means of long deck tackles leading to the *New York's* capstan located in the center of the pontoon deck. At the other end the billboards were not completed, and never were, as the material for them was subsequently used at sea for strengthening plates to keep the dock from coming apart. It was therefore a more difficult job to get the anchors up at that end and landed on deck, but this was simplified greatly by the able seamanship of Captain Hutchinson of the *Cæsar*. He noticed that the chains were of a size that would fit the wildcats of his steam capstan, volunteered his services, and brought the *Cæsar*, bows on, up to that end of the dock, keeping her thus underway for several hours in a tideway and giving an exhibition of ship mastery that could not well be excelled. We on the dock unbitted the chains one at a time and gave him the bitter ends by means of a tail rope previously passed through the *Cæsar's* hawse pipe. They then hove the anchor up with their steam capstan and when it came up to the bow, considerably higher than the deck of the dock, we got hold of it with tackles and by hauling in while they eased out the chain from the *Cæsar* successfully landed it. All four anchors at that end of the dock were picked up in that way, not without trouble, for they had been so carelessly dropped after the self-docking tests of the dock that we found two of them, from opposite corners, foul of each other and very hard to get clear.

The forenoon of December 28 was consumed in running the towing lines from the dock to the *Brutus* and *Cæsar*, those two vessels being anchored in column at suitable intervals ahead of the dock. The so-called "bow" of the dock—the end upon which was the swinging bridge—was pointed up stream, which made it necessary to turn completely around after getting underway, to aid in which evolution the *Potomac* was put on ahead of the *Cæsar*. Each collier had one of the 200-fathom 6-inch hawsers upon the drum of her towing machine, the hawser being shackled into a double 15-inch manila span; one of these was between the *Cæsar* and the *Brutus* and two, shackled end to end, were in the interval between the *Brutus* and the bridle on the dock. While getting underway and working out of the river the greater part of the wire lines were kept reeled up on the drums of the towing machines, but were nearly all paid out as soon as

open water was reached. These practical details may appear trivial to the readers of the Naval Institute and may be thought more in place in a "First Mate's Manual," but if there is ever another expedition of the kind the people engaged in it will be grateful for anything in print relating to the small but important details of this one. Little practical matters like these unquestionably pertain to the naval profession, even if not military, and should not be beneath the consideration of naval officers. When the expedition was fitting out, the suggestion reached me from two or three sources, all naval, that the service assigned was rather unprofessional and even demeaning. It is not my task, for obvious reasons, to offer any plea for seamanship in the navy, but I think I may ask without presumption, in the present commendable enthusiasm about target practice and gunnery, if many officers are not forgetting that common seamanship is still a professional requisite?

Everything being ready, the colliers and the dock hove up their anchors and at 2.30 p. m., December 28, the long journey began without a delay or hitch of any kind. The small collier *Lebanon*, from which we had been coaling when we had nothing else to do, and the tug *Mohawk* were put alongside the dock on the inshore side while getting underway to aid in turning it around and to prevent any tendency to swing into shoal water. The *Potomac* let go when well pointed out of the river, leaving the two colliers towing. The start was disappointing, for the night came on thick with much rain and many squalls from almost dead ahead, making the navigation of the bay difficult and keeping the speed down to less than three knots. The weather was better in the morning and the *Potomac* resumed towing ahead of the *Cæsar*, increasing the rate of progress to between three and four knots; this was still disappointing, as there was a general impression communicated to us from naval discussion that we ought to make at least five knots per hour. At 10.30 that evening we passed out at the capes of the Chesapeake and into the Atlantic ocean, where numerous adventures and novel experiences awaited us.

December 31 marked the first whole day from noon to noon that we were at sea and the day's run was 111 miles; this was encouraging and led us to hope that the five-knot prophets might not be so far wrong after all: a hope that was doomed to be blasted, for in the event we did not equal that day's run until

nearly three months later, when with the aid of the surface current that sweeps through the Strait of Gibraltar, we made 115 miles the day that we entered the Mediterranean Sea. December 31 was distinguished in our annals for more things than good speed. It was Sunday and the first comfortable day we had known for many weeks; we were in the gulf stream with warm air and water about us, and the men in clean white working clothes, all in great contrast to the cold, dirt, and incessant hard labor that had been our portion for more than two months at the Boston and New York navy yards and in the Patuxent river. Besides being the last day of the year, the day also came near being the last one of the dry-dock expedition, as I shall now attempt to relate.

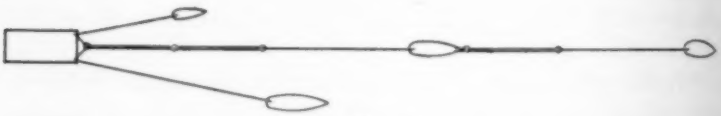


FIG. 1.

Various methods of towing had been discussed before the expedition started and all agreed that it would make too long and cumbersome a tow to put all four of the towing vessels in tandem ahead of the dock, besides subjecting the tow line nearest the dock to great strain. An arrangement like that shown by Fig. 1 had been proposed and was considered worth trying, as it would distribute the strain on the tow lines and, apparently, would tend to keep the dock straight in cross winds and seas. The *Brutus* and *Cæsar* were to tow in tandem ahead and the *Glacier* and *Potomac,* with shorter lines, were to tow from the forward corners. To give this scheme a trial, the *Glacier* steamed up to the dock from astern and passed slowly along the starboard side of it to throw a heaving line aboard. The *Potomac* at the time was towing ahead of the *Cæsar* and the flotilla was making about 4½ knots on a course S. E. ¼ S. The sea was smooth but there was considerable swell, and just at that time there was very little wind —light airs to light breezes at the most, from south.

At a speed slightly greater than that of the dock the *Glacier* passed at a distance of 40 or 50 feet, a heaving line was thrown across and with it a stout messenger line was hauled over, with which to get the end of the wire towing hawser on board the

dock. Then, when the stern of the *Glacier* was almost abreast of the starboard forward corner of the dock, that unwieldy craft began one of its kite-like swings to starboard. Seeing the distance closing in, Commander Hosley on the bridge of the *Glacier* put the helm to starboard to sheer the stern away from the dock, at the same time ringing up full speed ahead on the engine room telegraph. The dock's movement was, however, too sudden and unexpected to be avoided and her corner hit us twice far aft on the quarter; first lightly, and then, on the next swell, heavily, dishing inward a considerable area of plating to a depth of about six inches, breaking one frame, starting open a seam, and shattering several square feet of marble panelling with which the ward-room mess-room was finished. The damage was about twelve feet above the water line and was in itself of no importance, but the immediate result of the impact brought us face to face with a genuine peril. The blow forced the stern of the *Glacier* over to starboard, the starboard helm assisting, and the ship became pointed diagonally across the interval immediately in front of the dock. It was a critical situation affording no time for reflection but demanding instant action. To have tried to turn clear in that limited space with a port helm would almost certainly have resulted in fouling the *Glacier's* screw with the tow-lines. Without hesitation, Commander Hosley went ahead with starboard helm and we actually passed over the tow-lines without accident, the ship's stern crossing certainly less than one hundred feet ahead of the on-coming dock. The clipper form of the *Glacier's* bow enabled her to ride down the line and force it underneath when she met it. It is not pleasant to conjecture what would have happened had the line caught on her bow and stopped her, but it is safe to say that the least result would have been damages to the dock and the *Glacier* that would have compelled the return of the expedition to port.

Another perilous adventure was in store for us that same day. After the crew's dinner hour we took a position on the starboard bow of the dock as nearly ahead as we dared go without getting too close to the tow-lines, and floated a messenger line to her by means of buoys. This took considerable time, as the lines fouled the sharp overhanging corners of the dock after being grappled and had to be run several times. About 5 p. m. we got the end of our 6-inch steel tow-line on board the dock and shackled into

a pelican hook secured at the starboard forward corner. After beginning to tow we unreeled about 150 fathoms of this line, making our position about half the distance between the dock and the *Brutus*. Our line, leading off the port quarter, tended to drag the stern of the ship in that direction and obliged us to carry considerable starboard helm to keep on the course.

In the meanwhile the weather had become threatening, with rising wind from S. S. W., falling barometer, and fierce rain squalls, the consequence no doubt of our being then on the eastern edge of the gulf stream. About 6.30 p. m. the ship failed to respond to a full starboard helm and reserve engine speed and came up until the wind caught her on the port bow, when she fell off rapidly, unable to help herself, and was soon being dragged stern foremost by the dock: a very awkward predicament for a 7000-ton ship. Figure 2 will give a better idea of the situation

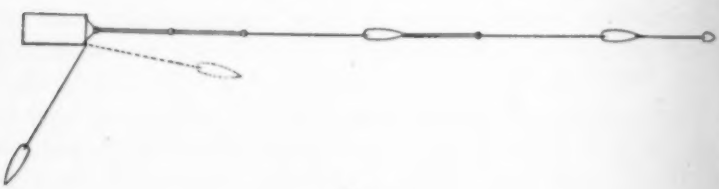


FIG. 2.

than can be obtained from any description. A furious rain squall of gale force (7 to 8) was blowing at the time and the lights on the dock were seen so dimly through the driving rain that we could not tell how close we were being drawn toward collision. Full pressure of steam in the cylinders of the towing engine failed to hold the strain of the tow-line, which veered out by bounds and with an appalling sound as the compressed steam forced open the cylinder relief valves, while the deck, heavily supported and reinforced as it was under the towing engine, fairly jumped with each attack upon it. The two large king posts previously mentioned as having been put in at New York were both whipped out and thrown overboard by the tow-line and half the top of one of the towing frames went with them. It was a miracle that no one was killed by these heavy timbers when they were flying about the deck. Altogether, it was a decidedly bad quarter of an hour.

Commander Hosley tried his utmost to regain control of the

ship, but in the high wind blowing it could not be done, and as we could not see clearly whether we would foul the dock or not he gave the order to let go our line. We unclamped it from the drum of the towing machine and let it run overboard, it going with such spitefulness that its marks are still on the ship. It was subsequently hauled on board the dock and we got it a day or two later after another memorable struggle with refractory forces and reeled it back again upon our towing drum. The wind veered suddenly to N. W. early in the first watch, blew with gale force for two hours, and then subsided to a moderate breeze from the same quarter. The *Glacier* never attempted that method of towing again, but on two or three occasions afterward when it was fairly smooth the *Potomac* was put on one corner of the dock for short periods and contributed something to the general progress. Throughout the serious incident just described the other vessels continued towing ahead, prevented by the rain and darkness from knowing that we were having trouble, and we learned from them later that they knew nothing of it beyond the fact that we had cast off from the tow.

The next three days were comparatively peaceful; the wind, usually light, veered gradually from N. W. to north and N. E. and thus on around until it was about S. E., or ahead, by noon of January 3. The runs for those three days were 79, 98 and 101 miles; still disappointing, as we had not yet had enough experience to realize what a huge task we had ahead of us. Valuable experience was close at hand and arrived the following day, with the wind in the southeast quadrant at first, gradually increasing and veering until by 1 p. m. it had reached the force of a moderate gale from S. S. W. and raised such a sea that any progress in towing was impossible. The *Potomac* had cast off at 8 a. m. to go to Bermuda for coal and to take the mail, and we had much difficulty and some danger in getting the mail on board her, so rapidly did the sea make. The colliers left attached to the dock took the most comfortable position, which was about head to sea, and steamed only fast enough to check the drifting of the dock to leeward. Even under such conditions the strain on the towing gear was great and at 3 p. m. the *Cæsar's* towing engine was disabled by several teeth being torn out of the drum gear and the engine shaft being lifted out of its bearings. They succeeded in bitting the wire hawser and so held on. Some studs

were subsequently put into the drum gear in place of the broken teeth and the machine thus made fit to use for reeling in slack wire, but the *Cæsar* always towed thereafter with her line bitted, the accident having proved that towing machines of this size cannot manage 12,000-ton dry docks in gales of wind.

The day's run from noon January 4 to noon the 5th was 21 miles, which served as a damper upon preconceived estimates of what we were going to do and furnished something definite upon which to calculate for the future. The wind continued all day January 5 in the S. W. quadrant, of force 4 to 6, with moderate sea, the tow facing the weather. The *Glacier* took position ahead and distributed oil on the water, but so far as we could see there was no change in the seas that broke over the bows of the colliers and upon the deck of the dock. The morning of January 6 the wind fell to a gentle breeze and veered around to N. W. Captain Hutchinson of the *Cæsar* suggested by wireless that advantage be taken of this wind to get as far south as the 30th parallel where he thought we would be less liable to have bad weather; this being approved, the two colliers started off to the S. E. towing the dock with wind nearly astern and orders to go to Lat. 30 N., Long. 65 W. At the same time we in the *Glacier* started for Bermuda to pick up the *Potomac*. This separation was necessary because the *Potomac* had been ordered to find us on the 32d parallel and as she had no wireless outfit the only way to inform her of the change of route was to go after her. We met her when she came out of port the next morning, and that evening we both rejoined the squadron.

The following day, January 8, the *Glacier* began towing ahead of the *Cæsar*, the great increase in power thus put on making it necessary to stop for a short time to permit the *Brutus* to bitt her wire line, her towing machine not being able to withstand the increased strain. The *Potomac* was taken in tow astern of the dock, which thereafter became the usual arrangement while crossing the Atlantic. The *Potomac* kept steam enough to take care of herself and when the weather made her too uneasy in tow she would cast off and keep along with the flotilla under easy steam. She cast off frequently also to aid in distributing provisions or for other services. In the protracted bad weather that we had a little later the *Potomac* certainly had a hard time and life on board her must have been almost intolerable. There were times when it did

not seem possible that a vessel so small could preserve herself, but she always came out right side up and without much damage.

The *Glacier* towed at first with one of the single 15-inch manila hawsers, 200 fathoms long, shackled to the 6-inch wire from her towing machine. About 170 fathoms of the wire hawser would be unreeled, making the tow-line about 360 fathoms long with a dead weight of two-thirds of a ton near its middle where the thimbles and shackles came together. The plain end of the manila hawser was taken over the *Cæsar's* bow and bitted on her forecastle. This was a clumsy arrangement because of the amount of

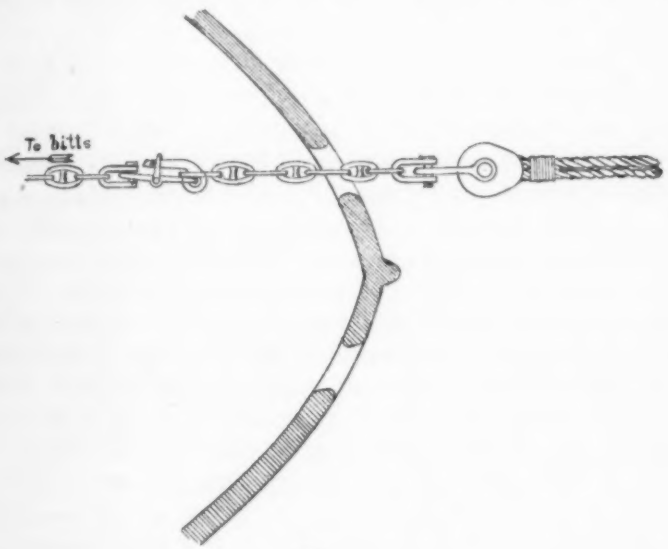


FIG. 3.

work necessary on the *Cæsar* after they got the end of the hawser on board. They had to get enough of it to take to the bitts, which was no light task, as a line of that size is not an easy thing to haul out of the water, and they had to hold it up with the cat fall while parcelling could be put on the part that would lie in the bow chock. In a seaway with the ships going ahead, and particularly because the *Glacier* is very hard to keep under control at low speed, this operation was always attended with great risk of the *Cæsar* losing the line after they had got the end on board and before it was bitted. The first step toward improvement was for us on the *Glacier* to find out how much end the *Cæsar* needed

(about 9 fathoms) and to put the parcelling on before running the line. The messenger line, a whole coil of 5-inch or 6-inch manila, and sometimes two bent together, was hitched to the hawser just below the parcelling and stopped along at intervals to the end. This messenger was rove through a snatch block on the *Cæsar's* anchor davit and when it brought the end of the hawser up to the block they had only to cut the stops one by one as they arrived and pass the big end, thus liberated, along to the bitts, ceasing to heave in of course when the parcelling came up over the bow chock. The heaving in of such a heavy line, it may be added, required the use of the steam capstan on the forecastle backed by a winch on the well deck.

This resulted in the saving of some time and nervous distress, but still had the great drawback that it was necessary to cut the 15-inch hawser forward of the bitts when it had to be let go in a hurry, and it was so cut four times before we had opportunity to prepare another improvement. This began by splicing an eye in the end of the hawser, well protected by parcelling, serving, and leathering, and putting therein one of the large shackles figured on the plate, so it could be shackled instead of bitted on the *Cæsar*. This passed through three or four stages of development and finally reached the arrangement shown by Fig. 3, which was so satisfactory that we did not try to improve it. With this it was only a matter of a few seconds after the end of the short chain came up over the *Cæsar's* bow before the pelican hook would be slipped into place and the welcome international letter Y—"hawser is fast"—would be run up. This put an end to the long and anxious minutes of dread lest the messenger carry away while holding the big hawser up against the pitching and wallowing of both ships, and certainly added much to the peace of mind of the chief officer of the *Cæsar* and myself, who were both strenuously engaged when tow-lines were being run.

The *Brutus* always used a chain bridle over her bow dipped through a shackle in the end of the manila span from the *Cæsar* and never had any trouble with it for the simple reason that the towing train between the *Brutus* and *Cæsar* never carried away. The same elements parted at one time or another in all other parts of the train, so it may be considered merely as luck that no break ever occurred in the space mentioned.

From January 8 to January 12 we proceeded eastward, making

enough southing to reach the 28th parallel on the latter date, that having now been decided upon as the proper latitude for the crossing. The wind, not exceeding 4 in force at any time, was forward of the beam or ahead practically all the time, and the sea was only rough enough to give the ships a moderate sea motion. We made 388 miles during the four days, with which we were satisfied. The 12th the wind freshened and the sea became so much heavier that even with racks our mess table could not be set and meals had to be taken, picnic fashion, wedged somewhere into a corner. The colliers and the dock were very unsteady and the *Glacier* was much worse, establishing beyond dispute, I think, her claim as the champion roller of the world. The little *Potomac* presented a spectacle of abject misery, though not without an element of the picturesque, as she struggled with the tall seas. Rain added to the discomforts of the day. About half past ten that night the *Brutus* burned the odious letter V—" hawser is carried away "—and the dock was adrift, the 6-inch wire hawser from the *Brutus*' towing machine being the one that had parted. The dock began drifting to leeward, about N. W., and we all stood by her, working on our lines to get ready to connect up the tow again.

The dock had the most work to do, as the heavy chain bridle with two of the 15-inch manila spans and about 100 fathoms of the 6-inch wire attached to it had to be hauled in, but all this heavy work was done and the lines ready for running again before noon the next day. The *Brutus,* Captain Hendricks, did remarkably quick work, getting the drum clear of the broken hawser and a new one reeled on in time to report ready at 1.50 a. m., a little more than three hours after the accident had occurred. On the *Glacier* we had the *Cæsar* let go our line and discovered that it was a big undertaking, working with all hands in the darkness and rain, to get twelve hundred feet of water-soaked 15-inch hawser back on board the ship. We were hampered greatly by lack of deck room on which to work, our deck being much obstructed by ventilators and deck houses, and the towing frames put on at Boston were provokingly in the way. We had to haul this line in many times during the cruise and with experience came to adopt a number of makeshifts and expedients that finally brought the operation down almost to the system of an established drill, but it never became an easy task. I shall resist the temptation to describe the troubles we had and how they were overcome, but I

will say that one of our most baffling difficulties was caused by the malignant and almost animate manner in which the big hawser would cable-lay itself as the bights were hauled in on deck. The *Cæsar* avoided trouble with her line by keeping the *Brutus* in tow, but this made the work more difficult when it came time to get hold of the dock again.

About 1 p. m. of the day following the break the *Cæsar* towed the *Brutus* as close to the dock as was prudent and the *Potomac* succeeded in carrying across a messenger line with which an end of one of the 15-inch double manila spans was hauled over and shackled into the end of the new wire line on the *Brutus'* drum. This took longer than it takes to write it, as the sea was still heavy, the dock drifted faster than the vessels, and the weight of the gear to be handled was about up to the limit of the facilities for holding it, so it was 4 p. m. before the two colliers began towing on a course again. An incident of this accident was damage to the stern rail of the *Brutus* that cost more than $2000 to repair at the first port we stopped at. The next morning the *Glacier* went ahead of the *Cæsar,* ran her lines, and began towing again, the *Potomac* being taken in tow astern of the dock. Everything proceeded satisfactorily until 4 a. m. January 17, when "without warning," as the newspaper writers say, the *Glaciers'* 15-inch line parted where it passed through the bow chock of the *Cæsar.* This was the simplest accident that could occur, as it left two ships fast to the dock, and so little was off the end of our line that we did not have to get a new one ready. After heaving in our lines and getting them ready to run again we took the *Potomac* in tow with an 8-inch manila line, the weather indications being such that it did not seem advisable to shackle into the main tow at that time.

The next morning, January 18, we all stopped for a short time while funeral services were conducted on board the *Cæsar* over the remains of a Chinese seaman who had died the night before of beri-beri. Then we proceeded; the *Glacier* shackled in ahead of the *Cæsar* and the *Potomac* took her place in tow astern of the dock. In running lines to the *Cæsar* we floated them with buoys in every instance but one, when the weather permitted the use of a boat. The buoy method is very simple and easy as described in the seamanship books and a midshipman can write it out nicely on the blackboard and get a 4 for it any time. In real life, how-

ever, on the high seas, it is difficult. With a stiff breeze blowing across the course or on the bow, as almost always was the case with us, and a good sea running, it was difficult to keep as clumsy a ship as the *Glacier* parallel to the course of the colliers or at the same speed that they were advancing, which made the game of catching the buoy a rather engaging one for the *Cæsar*. The *Glacier* was about six feet lighter forward than aft, which caused her to fall off rapidly if stopped or run at dead slow with the wind on either bow and greatly increased the difficulty of keeping her in place long enough to run the lines. Even after the *Cæsar* got the end of the messenger line to her capstan there yet remained ample trouble for us, for two hundred fathoms of wet 15-inch line is about as difficult to get overboard safely as it is to get back again, and we always had a violent time with jammed check stoppers, foul slip ropes, and innocent ordinary seamen who seldom failed to step inside each bight of the hawser as it started to run. When one of these events was over the deck looked as though a battle had been fought on it, strewn as it would be with stranded cordage, splintered woodwork and broken tools. Under very adverse weather conditions it took us once four hours to get hold of the *Cæsar*, but an hour was usually sufficient time and on two or three occasions the whole operation was completed within fifteen minutes after streaming the buoy.

Following January 18 for nearly a week came the most comfortable and successful period in the transatlantic voyage. The wind was mainly in the northeast quadrant and light, and the sea was smooth except for a swell that kept the ships all rolling more or less. Going east along the 28th parallel as closely as possible we made 612 miles in six days, and might have made several miles more had we not stopped two or three times to issue provisions and transfer stores. There was a funeral also, another of the *Cæsar's* men having died. The satisfaction of this period was increased by our getting into touch with the world through the armored cruiser *Maryland*, the easternmost of a chain of ships that had been deployed into the Atlantic for wireless telegraph tests. She telegraphed us the more important items of news of the world and our navy news, which was very welcome. After leaving the United States we had kept in communication with the wireless station on Cape Hatteras for three weeks and until nearly 1400 nautical miles distant, but as that is a commercial station in busi-

ness for money no news had been given us more important than the telegraph operator's comments on the weather.

January 24 saw the end of our good weather and the beginning of a hard luck period that lasted nearly a month and destroyed every hope of making the voyage within a reasonable time. The wind had veered slowly the preceding day and reached S. E. the 24th, blowing fresh with frequent squalls of heavy rain varying from moderate to strong-gale force (7 to 9 by the Beaufort scale). A rough sea resulted, and between wind and sea we had to abandon the idea of making any progress, but faced the weather and steamed enough to keep steerage way. The *Potomac* had to cast off from astern of the dock and take care of herself. The next

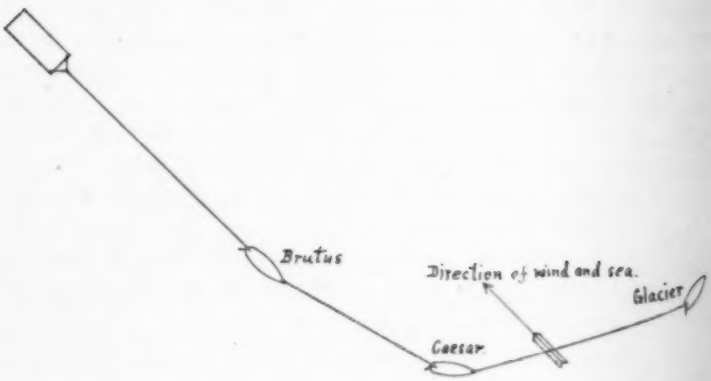


FIG. 4.

day the weather was worse and troubles began. About 10 a. m. the *Glacier* lost steerage way, though making all the revolutions possible, and fell off to leeward into the trough of the sea. From this position she could not recover, her light bow preventing her from coming up, while the effect of her struggles dragged the *Cæsar* off also and put a dangerous strain on the tow lines. Fig. 4 will give an idea of the situation at that time. About 1 p. m. the *Brutus* gave warning that the tow lines were in danger, and the *Glacier* therefore gave up the attempt to get back head to wind and had the *Cæsar* cast her off. We had a wild time getting that line on board in the gale and tempestuous sea, so heavy that water came on board over the stern while we were working there.

When free from our strain on her bow the *Cæsar* got pointed head to wind by the rather simple expedient of requiring the

Brutus to stop steaming ahead, when the dock, acting as a drag, hauled the colliers stern foremost until the *Cæsar* was straightened out, both colliers then going ahead for steerage way. But the dock was too big and heavy an object for them to hold long against such weather and about 6 p. m. the *Brutus* signalled that her hawser had parted, supplementing the message soon afterward with these disagreeable particulars—"Towing machine a total wreck; wire went by the board and carried away close to hole where rove through drum. Clamp still remains on drum, and about forty fathoms of wire left." Released from restraint, the dock started back toward the coast of the United States at a speed rather better than we had averaged in towing it in the opposite direction, and accomplished something more than one hundred miles of the return voyage before we again got it under control. In the dark and stormy night it was impossible to do more than stand by the dock, steaming slowly along with it and turning around occasionally when getting too far ahead. Those turns will be remembered by all who participated in them, for it seemed sometimes that the *Glacier* would roll completely over. As on the occasion of a former breakdown, the *Cæsar* kept the *Brutus* in tow.

The next day the weather continued so bad as to forbid any attempt to get near the dock and we had to watch it drift away, unable to even try to prevent it. The barometer this day was unsteady, about 30.00, fluctuating a few hundredths above and below that mark. More than a week before it had begun falling slowly, from 30.29 on January 19 until it reached its lowest point, 29.70, the afternoon of the 23d, when the bad weather was just beginning, rising thereafter slowly throughout the period of storm. It was a sure-enough case of "long foretold, long last." The 27th the weather had improved to some extent, but there was still a boisterous sea. The wind had decreased to a moderate breeze and moved around to about S. S. W., which changed the drift of the dock to the eastward of north. The *Potomac* about noon got near enough the dock to run a messenger line for hauling over a towing span but she could not hold the dock from drifting and was dragged by it slowly to leeward stern foremost. This situation endured the whole afternoon, the *Cæsar* towing the *Brutus* clockwise around the dock several times and passing close to windward of the *Potomac* each time in an effort to get a line from her, but the *Potomac* drifted out of reach each time. The *Glacier*

eventually sent a whale boat, though it was not a good time for a small boat to be abroad, and on the next round trip of the colliers this boat, commanded by Chief Boatswain James Dowling, carried a line from the *Potomac* to the *Brutus*, which enabled the latter vessel to get the end of a towing span on board and secured to a 2-inch chain bridle over her stern. It was after 7 p. m. before everything was fast and the two colliers began towing the dock to the eastward. The *Glacier* towed the *Potomac* for the night.

The following morning we took the *Potomac* alongside the *Glacier*, it being absolutely necessary that she have coal, and gave her 37 tons before the parting of the lines between us made us stop. There was considerable sea and she rose and fell fully twenty feet alongside us, destroying big bale fenders, badly damaging her side, and violently removing all our chutes and guards on that side, but it was a case where eggs had to be broken or there would be no omelette. That night, or more exactly at 12.30 the next morning, the chain bridle at the stern of the *Brutus* parted and the dock was adrift again beyond the reach of all profanity. The colliers cast off from each other this time, having had enough of the scheme of towing one another, and the day was employed in getting towing gear ready to run again and in hoping for better weather, the state of the sea that day precluding any attempt to get hold of the dock, Next morning the *Brutus* unaided got hold of the dock and held it up in the wind while the *Cæsar* ran her lines from ahead of the *Brutus*. As before remarked, this kind of work does not proceed as smoothly in the open sea as it does in the text books and it was 2 p. m. before the colliers started off to the eastward with the dock. The rough track chart shown by Fig. 5 indicates the wanderings of the dock during the period just described.

The dock was taken in tow this time from what we called its stern end, where a bridle shackled to a double 15-inch manila span had been kept ready for use ever since the expedition started. By the former accidents the dock had acquired two long pieces of 6-inch wire hawsers from the *Brutus* and these had been spliced together, making one line about 250 fathoms long with a thimble in each end. One end of this long line was shackled to the manila span just referred to and the other end was hauled aboard the *Brutus* and shackled to a new 6-inch wire line; the

inboard end of the latter was bitted on the *Brutus,* as her towing machine was out of commission, the bitts being backed to the mainmast by chain cables. All these tow-lines made a very long drift between the *Brutus* and the dock—about 540 fathoms, or

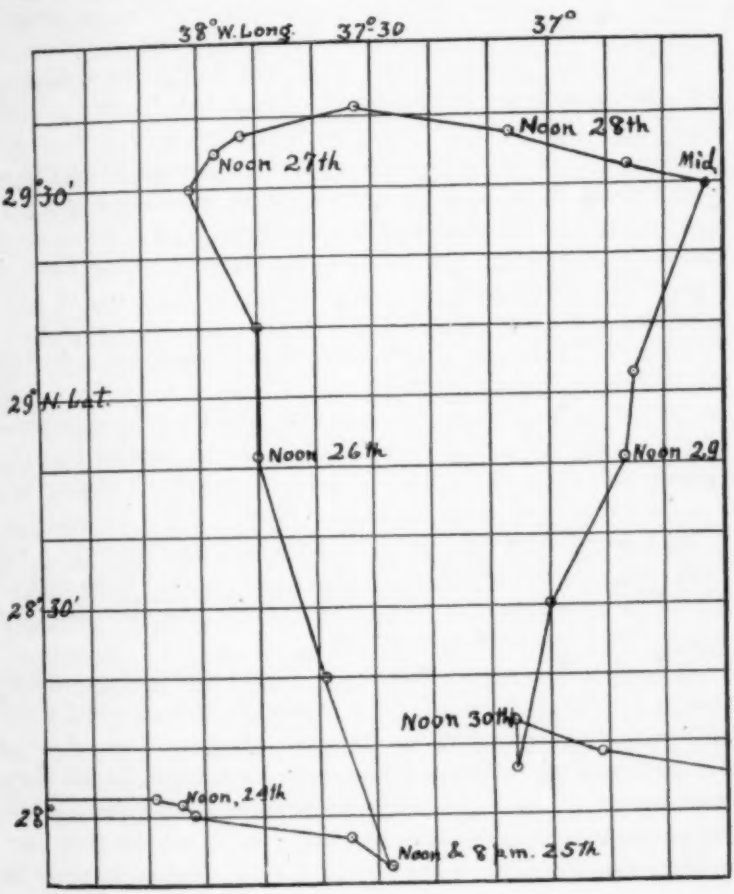


FIG. 5.

more than half a mile,—but it was an effective one and did not carry away. The whole tow as made up this time was a mile and a half long from the bow of the *Glacier* to the stern of the *Potomac:* as ordinarily composed it was only little more than a mile in length.

The *Glacier* towed the *Potomac* that night, but the next morn-

ing took her place ahead of the *Cæsar*, the *Potomac* making fast astern of the dock, and the procession resumed its way to the eastward. The wind was from N. E. east and S. E., of force about 4, with many rain squalls, and the sea was heavy enough to make us all uncomfortable, the *Glacier* especially so, as we were then engaged in hoisting coal out of the holds and transferring it to the bunkers. Not a pleasant occupation in the best of weather, but when rolling so that the hoists of coal would swing viciously more than the width of the ship it became slow, difficult and dangerous work. The weather conditions, adverse as they were, soon became worse, and by February 4 we were again in a S. E. gale—logged as a whole gale at one time—with a sea to correspond. For four consecutive days, the big ships toiling ahead on the tow-line like oxen, our day's runs were 30 miles, 18 miles, *minus* 24 miles, and 22 miles, or 46 miles made good in 96 hours. The night of February 4 the *Glacier* fell off into the trough of the sea in exactly the same manner as had happened once before, and we had to let go and haul in our lines, shackling in again ahead of the *Cæsar* the morning of the 6th. In the weather then prevailing both these operations involved more toil and anxiety than can be understood from reading of them. From February 6th to the 9th the wind was not so violent, blowing with force 4 to 5 from east, or dead ahead, most of the time, and in those days we advanced 47, 42 and 46 miles respectively. Another Chinaman was buried from the *Cæsar* the 7th.

Meanwhile, we were watching the steady approach of a trouble that could not be avoided. The *Potomac*, though being towed and exercising economy, was burning about six tons of coal a day and bringing nearer and nearer the time when she would not have enough on board to carry her through another gale. Nothing perhaps during the whole history of the expedition gave Commander Hosley more anxiety than did this coal problem of the *Potomac*. We hoped for moderate weather that would allow us to take her alongside, but it did not come, and her noon report February 8, only 22 tons on board, gave warning that no more waiting would be safe and that something must be done. At daylight the next morning we left the tow, hauled our lines on board, took the *Potomac* alongside, and began putting coal upon her after deck, using cargo slings that landed 1500 pounds at a time. The sea was heavy and it was wild work and did not last long,

as her pitching parted a 4-inch wire bow-line to which she was riding and so much damage to our side and herself was being done that we had to let her go, but not until we had poured 15 tons of coal upon her deck. We took her in tow with a 4-inch wire line and spent all the rest of that day trying to rig a trolley transferrer to her, but found it impracticable owing to the pitching of the two vessels, that of the *Potomac* being extreme. The next day we got an under-water hauling line into operation and with two days of hard work transferred about eleven tons to her, barely enough to keep her alive, but enough to postpone the day when she would be helpless. We then devoted a Sunday to rigging a substantial derrick, reeving off heavy lines that could handle several bags at a time, and otherwise improving our appliances, so that between dawn and dark the next day 22 tons were hauled over to her under water, besides a quantity of frozen meat and other provisions, for it appeared that famine "shrieked" in the *Potomac's* pantry as well as in her coal bunkers.

The sea became less rough the next day and we called her alongside and dumped 43 tons upon her in short order, shoving her off with more than 80 tons on board altogether. Towed her that night, and the next morning resumed our place at the head of the tow, having been diverted just six days by the exigency of the *Potomac*. In those six days the colliers had towed the dock 303 miles to the eastward, edging also gradually northward in the vain hope of getting out of the limits of the wind that so persistently opposed us. They sometimes passed out of sight of us ahead while we were working on the coal problem, but we closed up with them each night, towing the *Potomac*. In towing her, after parting one or two 8-inch manila lines, we found the best way was to give her about 80 fathoms of 4-inch wire to which she shackled a bower chain and veered out 60 or 75 fathoms. The weight of the chain gave sufficient drop to the tow-line to make it yield easily to the deep pitching of the ships, and we had no more trouble with it.

Another serious matter was causing anxiety at this time. The rough seas that we had encountered had worked loose a great many rivets in the joints on the dock where the different sections were fastened together, and a condition had been reached where it was doubtful if that structure could hold together through another gale. It would take too much space to describe the

details of construction that were defective and I shall have to be content with the statement that the angle bars and rivets of which the junctions were formed were not heavy enough to withstand the strains that motion in a seaway put upon them, though they were amply strong for a fixed steel structure on shore. By using material left on board from unfinished work, some temporary strengthening plates were bolted up, but it was decided advisable to seek the nearest port where permanent repairs could be effected. This decision was the more positive because we had been so long at sea that the coal and water supply on the dock was getting very low. No condensers had been provided for the steam machinery on the dock, and as the many accidents had caused that machinery to be used a great deal tens of thousands of gallons of fresh water had been blown into the air in the form of exhaust steam. After our experiences with the *Potomac* we were not disposed to try to give either coal or water to the dock in a seaway.

Being thus compelled to seek "any port in a storm," we headed for Las Palmas in the Canaries, carrying our adverse winds with us until actually within the lee of that group of islands. The *Potomac* was detached February 17, when about 400 miles from port, and sent on ahead with despatches and with the dock expert, who was to make arrangements for the necessary repairs. The rest of us plodded on, dragging our incubus behind us, and the morning of February 21 arrived off the south side of Teneriffe, where we stopped and spent the day letting go and hauling in towing lines and running others suitable for towing into port. The *Brutus* with no towing machine to use could not heave in her lines, they being far beyond the capacity of winches, and the whole long train of lines from her had to be hauled on board the dock, the *Brutus* then being out of action as the damages she had sustained disqualified her for towing. The *Cæsar* had secured to the other end of the dock with the wire line from her towing drum and the *Glacier* ran her same line to the *Cæsar's* bow. The two ships then proceeded with the dock in tow but the (to us) short scopes of tow-lines gave us no confidence and the following morning we stopped and put in a hundred fathom double manila span between the *Cæsar's* line and the dock. At noon the next day, February 23, we stopped off Las Palmas and the dock hove in this span, the *Glacier* cutting out of the tow at the same time.

A light breeze was setting in shore, drifting the dock toward it, and there was a very anxious time for an hour or two while this work was in progress. The span was at last gotten in and the wire line secured, when the *Cæsar,* now entirely alone, got the dock pointed and towed it about two miles to the port of La Luz, passing safely through the narrow opening between the breakwaters and landing it alongside the east mole as skillfully as a steam launch should bring a cutter alongside. We were just 57 days from the Patuxent river.

We were three weeks at that port having repairs made on the dock that would easily have been accomplished in the United States in half the time and at much less cost, but we were in contact with a breed of men that cannot be hurried and that has all its enterprise in promise for to-morrow. About 6000 rivets were renewed, new angle bars fitted and heavier ones substituted for the old ones, so that when all was completed the dock was more seaworthy than when it left the United States. We hastened this work much by making up a working party of twenty mechanics from our ships who worked seven hours each night under the direction of the ships' engineers and accomplished a very fair proportion of all the work done. The delay was availed of to repair the damages that the *Potomac* and *Brutus* had sustained, to obtain coal and water, and to buy a quantity of cordage, for, notwithstanding the very liberal supply we were fitted out with, the vicissitudes of the Atlantic voyage had destroyed almost everything we had from 8-inch manila hawsers down to small stuff. We also got there from the United States, brought by the U. S. S. *Tacoma* from Naples, three complete drum gears and other spare parts for the towing machines and were thus enabled to put those machines into good working order again. We were indebted to the wireless telegraph for these spare parts, for when the *Cæsar's* machine was disabled, January 4, we had telegraphed an order for repairs through the U. S. S. *West Virginia,* then in Hampton Roads about 500 miles distant from us, and a few days later we repeated the order to the *Texas,* off Charleston, whose call we had accidentally picked up.

The afternoon of March 17 the dock was taken to sea by the *Brutus* towing ahead, the *Potomac* alongside, and the *Cæsar* stern-to astern with quarter lines run so she could use them to steer the dock clear of the shipping and the mole heads. It was

a very difficult operation, but they got outside safely and the two colliers were towing toward Gibraltar before dark. The *Potomac* went with them and began towing ahead of the *Cæsar* the next morning. The *Glacier* had to remain behind to settle the bills, which were advantageous for the inhabitants of the port, that for coal alone being more than $30,000. Shortly after noon the next day the *Glacier* left port and rejoined her command at ten o'clock that evening. On this trip of 700 miles from Las Palmas to the Strait of Gibraltar we found, as we had in crossing the Atlantic, that sailing directions and pilot charts are not infallible; only in this case the failures were in our favor. A northeast (head) wind and contrary current were so certain for this region and time of year that we expected 50 miles a day to be a good average for the run. It was a pleasant surprise therefore to find light airs or light breezes only for several days and a smooth sea, except for a long westerly swell; the latter made us roll abominably but did not interfere seriously with progress, the colliers and the *Potomac* keeping up an average of about four knots all the time.

March 23 the *Potomac* was sent on ahead with despatches and mail to Gibraltar, the *Glacier* taking her place at the head of the towing column. In letting go the *Potomac's* line on the *Cæsar* it struck a Chinese seaman and broke his leg in two places besides injuring him badly about the head. The ships were rolling deeply, but we sent a life boat with the surgeon to attend him, sending the boat to bring him back later in the day. Both trips were made successfully but the boat was considerably damaged in hoisting the second time, being stove against a large mooring shackle in the ship's side located exactly between the life boat davits and near the water's edge. We always used a jackstay and lizard in lowering and hoisting boats in rough weather and much damage was thus prevented, but the device could not save the boat from the badly located mooring shackle just as it came out of water. Oil was used frequently on these occasions, but I am sorry to say that I never could see the slightest benefit resulting from it. A ship's boat is such a small object in a heavy sea that it is bound to be thrown about pretty roughly, oil or no oil.

Early the morning of March 25, little more than a week from Las Palmas, we passed in at the Strait of Gibraltar and that day broke our record, making 115 miles for the day's run, thanks to

the surface current through the strait. Our welcome into the Mediterranean was not cordial. Soon after passing Tarifa we met an easterly wind with much rain and the behavior of the barometer gave us great concern. That instrument had been falling slowly from 29.90 the day before and now began to go down at an almost alarming rate, reaching 29.31 at 8 p. m. Having become somewhat attentive to weather signs during our experience in the Atlantic, we were much interested in this phenomenon and I was myself completely deceived, not believing such a low pressure could be relieved without a gale and figuring to myself the loss of the dock should it break adrift in such narrow waters. But nothing happened: the wind, never stronger than a moderate breeze, veered around rapidly during the night to south, S. W. and west, the rain ceased, and when morning broke we were bowling along with a fine breeze astern and everything lovely except the barometer, which was still below 29.40. It appeared later that the barometer is not an oracle in those seas, for we had fair winds and bright skies for the next four days and broke our record once more, making 119 miles.

March 30th our luck changed. We had then advanced far enough to the eastward to open out that wide reach of the Mediterranean from the south of France to Algeria between the Balearic Islands and Sardinia, and there we fell in with a cold north wind and heavy sea, causing the ships to roll and labor heavily and putting great strain on the tow-lines. The *Glacier* finally had to let go, leaving the two colliers to hold the dock up against the seas and take chances on the tow-lines surviving. The lee shore, the coast of Algeria, was only about sixty miles away, but the situation was not serious, as the wind did not increase and the sea was not making, being an old one. It subsided the next day and had almost disappeared by dark, long before which time the *Glacier* had shackled in ahead of the *Cæsar* and we were all towing under favorable conditions to the eastward again. Four fine days followed, during which we made 450 miles and established a new record, having made 124 miles one day south of Sicily where an easterly current helped us twelve or fifteen miles at least.

Passing from the Malta Channel into the eastern basin of the Mediterranean we met a moderate breeze from almost ahead that gradually freshened during the following days, through the vari-

ous stages of breezes and gales, until after five days it attained the force of 10. The successive days' runs indicate the gradual development of this discouraging opposition—107 miles, 77, 52, 24, *minus* 40, and *minus* 52, the dock being adrift the last day. April 7, the day that we made 24 miles, the tow-lines began to complain and about 3 p. m. the *Glacier* let go and hauled in her lines, which was difficult work. The colliers continued to face the weather, but the dock took them steadily to leeward, as shown by the track chart, Fig. 6. The next day, April 8, moderate to fresh gales prevailed, with squalls of whole gale force (10), and a sea heavier and more disturbing than any that we saw in the Atlantic ocean. Just before noon the dock broke adrift and began

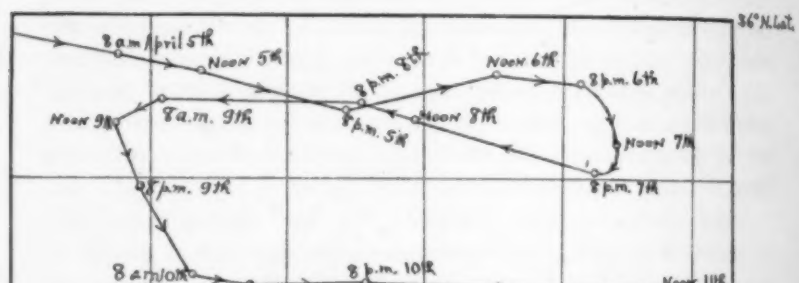


FIG. 6.

scudding rapidly to leeward broadside to in the trough of the sea and rolling and pitching more deeply than we had ever seen it do before. The break occurred in a big triangular shackle joining the legs of the dock's bridle to the first towing span, but as all parts of the shackle were lost, we never knew what part of it failed. The colliers cast off from each other and hauled in their lines, which in that weather was a laborious and difficult undertaking, the accomplishment of which before dark spoke eloquently of the energy and resolution of their officers.

The ships without steaming did not drift as rapidly as the dock, while in steaming as slowly as possible before the sea they would go too fast. This made it necessary to run before the sea and bow it alternately, and compelled us several times to pass through the ordeal that seamen dread—the turning of a steamer across a

heavy sea in a gale. The usual precautions were taken about covering hatches and securing movable articles, and oil was used freely with noticeably good results. The books say that before attempting to turn in such a situation you must wait for a lull in the storm, but my observation on this occasion and on similar ones in the Atlantic is that lulls are not frequent enough nor of sufficient duration to be worth considering. The *Glacier* was pooped several times when running before the sea, but that was almost wholly stopped by a very liberal use of oil from the well deck forward. A barrel was lashed in each water-way over a scupper and the oil allowed to run through a faucet in a very small stream, which was found a much more convenient and certain method than the use of bags. The colliers, being lower and heavier in the water, behaved better in this storm than the *Glacier* did, though they probably took more water on board, or clean over them, when making the turns. The *Potomac* weathered the gale without great distress, but she certainly presented a spectacle that was almost tragic.

This day, the most disheartening of the whole voyage, was cheered to some extent by friendly voices coming to us through the storm. About the time that the dock broke adrift our wireless office caught the call of the U. S. S. *Brooklyn,* then about 200 miles to the eastward of us, bound westward from Alexandria. We told her our troubles and received kind offers of assistance from her and also a promise to find us and stand by until the weather changed. Our messages were overheard by the British cruiser *Sutlej,* 100 miles or more away, and she also proposed to come to our assistance. As that vessel was homeward bound from the China station and probably in a hurry to get to England, it was very kind and seamanlike in her to offer to delay her voyage because of our misfortune. Lightning that evening stopped wireless telegraphy and we could not give these ships our position, in consequence of which we did not see the *Sutlej* at all and the *Brooklyn* did not find us until four o'clock the next afternoon.

An interesting and noteworthy incident of this storm was the presence on and about the ships of thousands of land birds, varying in size from large cranes, hawks and owls to small finches, swallows and thrushes, many of them of very beautiful colors and marking. Their necessities for food and water were such that they were almost tame and gave us excellent opportunities for

observing them at close range. I suppose that they were migrating from their winter quarters in tropical Africa to the summer breeding grounds in Europe and were caught in the gale at sea and overpowered. A few remained with us until we sighted land, but the most proceeded on their journey as soon as the wind abated. During the same time there were no sea birds about, which confirms the popular notion that such birds are sufficiently weather-wise to seek the shore when a storm is brewing.

The morning of April 9 found the situation somewhat improved; the wind had backed to N. E. and N. N. E. and decreased to force 5 to 7, making a cross surface sea on top of the old sea, which was still heavy and awkward for ships to maneuver in. Nevertheless, the *Brutus* and *Potomac* undertook to get hold of the dock and actually did so, the *Brutus* having the regular towing-lines hauled across and shackled ready for use by 11 a. m. This was the most difficult and dangerous piece of seamanship accomplished during the cruise and was greatly to the credit of the two vessels that did it. The *Brutus* was unable to tow the dock alone in the prevailing sea, but she controlled its drifting enough to direct the course about S. S. E. and thus made something to the good. (See track chart, Fig. 6.) The *Brooklyn* arrived on the scene about 5 p. m. and the *Tacoma,* from the westward, an hour later, we having been in wireless communication with both vessels all day. It appeared that the *Tacoma* had been cruising about the Mediterranean for some time looking for us and I believe her executive officer is prepared to furnish statistics relative to coal and energy expended and distances annihilated in that quest. Having found us, she remained in company until we entered the canal at Port Said and we were very glad to have her with us. The *Brooklyn* left us at 11 a. m., the 10th, and proceeded on her cruise. The sea was much less rough that morning and at 7 a. m. the *Cæsar* ran her lines and began towing ahead of the *Brutus,* the two ships taking the dock to the eastward at about three knots speed.

As soon as the *Brooklyn* left us the *Glacier* shackled in ahead of the *Cæsar,* but in working up to the full speed we parted the 15-inch manila hawser forming the span between our wire line and the bow of the *Cæsar.* The work of hauling this in, getting it out of the way, and getting another line out of the hold ready to run employed us several hours, lasting well into the night, dur-

ing which time the *Potomac* was put into our place to tow ahead of the *Cæsar*. In the morning she let go and the *Glacier* resumed her place at the head of the column, having put into use a new double 15-inch manila span. By that time all traces of the gale had disappeared; the sea was nearly smooth and the wind, from north, was only a light to gentle breeze. Under such favorable conditions we were making about 4½ knots to the eastward and there was not even a remote prospect of any breakdown, when at 5.30 p. m. the double 15-inch manila span between the *Brutus* and the dock parted, and the dock was adrift for the fifth time. Compared to all the other occasions this was easy, with smooth sea and no wind to speak of, but it involved several hours' work hauling in lines and ranging them for running out again, and on the *Brutus* they had to get up a new span and prepare it for use in place of the one that had carried away. All this consumed time and it was nearly 2 a. m. before we were all shackled together and towing again. The *Potomac* distinguished herself on this occasion by towing the dock alone four or five miles to the good while the other ships were working on their lines. The *Tacoma* contributed to the common welfare also by furnishing a boat to run lines when the tow was being made up.

Smooth seas and fine weather followed for five days, during which we made a little more than one hundred miles a day, none of the ships towing at full power because our towing gear was beginning to look very disreputable from long use and we were afraid of it. At sunset April 18 we all anchored in six fathoms, three miles off the breakwater at Port Said, thirty-two days from Las Palmas. The next morning the *Cæsar* and a canal company's tug towed the dock in to the Ismail basin at Port Said and the other ships followed in soon after. Officials of the canal company had boarded us before we anchored the evening before and said they were all ready to start the dock into the canal the next morning, which was certainly a pleasant surprise for us. They found, however, that the dock was drawing nearly eight feet, which prohibited it from going through until a considerable amount of dredging had been done. It appeared that the central office of the canal in Paris had been informed several months before by our Navy Department that the draft of the dock was six feet, and on that information they had widened two of the *gares* or sidings in the canal for places in which the dock could be tied

up to avoid stopping traffic. Perhaps the dock did draw six feet when it was considered finished, but after being equipped for sea with anchors, chains, coal, water, provisions, men, and stores of all kinds on board its draft was about 7 feet, 8 inches, and could not be made much less. The mistake cost us five days' time, which we mourned more than any time we had lost through bad weather, because it could have been avoided and because time was now precious just before the expected break of the southwest monsoon.

While waiting for the dredging to be done we had more than enough time to get coal and provisions, re-distribute the towing gear, buy some more cordage, and make all preparations for the next stage of the voyage. The natives there gave our young seamen a valuable object lesson in coaling ship, which was to be expected at a port that handles over a million tons of coal a year and has made a record of 600 tons an hour—ten tons a minute—put into passing mail steamers. When all was done, the towing ships entered the canal, the *Brutus* on April 24 and the *Glacier* and *Cæsar* the 25th, all anchoring in Suez Bay to wait for the dock. Commander Hosley returned to Port Said to take charge of the dock and the *Glacier* furnished eighteen men to go through the canal with it and satisfy the canal company's rule requiring vessels in transit to have adequate crews. We expected one or more of our ships to do the towing in the canal, but because they did not have twin screws the authorities would not permit them to try it. A canal company's tug named the *Titan*, of 3000 horsepower and twin screws, did most of the towing, assisted by a smaller tug ahead of her and the *Potomac* astern of the dock to push, and to keep the stern of the dock from yawing into the banks. She performed this difficult task so well as to excite the admiration of the canal officials.

The dock entered the canal the morning of April 27 and arrived at Suez at 6 p. m. May 1, having made the transit in less time and with less difficulty than had been expected. The chief trouble they had was because of a beam wind of considerable force when the dock was moored in the siding at Kilometre 54. The siding was on the weather side of the canal, which made it hard work and destructive to mooring lines to get into it and harder yet to stay there. Hawsers parted and had to be replaced, and the mooring bollards along the bank, though well anchored, began

coming home, making it finally necessary to veer all lines and let the dock take the ground easily on the opposite bank. This effectually blocked the canal and stopped all traffic for several hours before the wind permitted the dock to be moved. They anchored one night in Lake Timseh at Ismailia and the next night in the southern end of the Great Bitter Lake, being out of the way of passing vessels both nights. The trip from the latter point to Suez, 25 miles, was made in one day, arriving vessels being held at Suez that day to keep the canal clear. The canal officials were very attentive and courteous, the superintendent or director of each division going with the dock while in his part of the canal, and they detailed their best pilots. They were much elated at having put the dock through safely and so quickly, but said frankly that they hoped no more such things were coming that way. The dock was actually under way only 35 hours while in transit, or about double the time it takes a steamer to make the passage.

In making up the tow at Suez we proceeded to "load for bear," using much heavier gear than formerly. From Las Palmas Commander Hosley had cabled home asking that eight-inch wire hawsers be ordered from England, and we got them at Port Said; three 8-inch flexible wire lines each 200 fathoms long and looking almost too good to use. One each was reeled up on the towing machines of the *Brutus* and *Cæsar*, the drums of which fortunately were just big enough to take them, and the third one was reserved as a spare. The bitts on the colliers had to be enlarged to suit these larger hawsers, which was effected quite simply by putting a shell of boiler iron, about four feet in diameter, over the bitts and filling the inclosed space with cement. The dock had been originally supplied with 360 fathoms of 2½-inch chain cable for bridles, enough for two bridles at each end, one to use and the other kept bitted in place ready to use. Seven shots, or 105 fathoms, of this chain were now shackled into the legs of the bridle as a span in place of the double 15-inch manila spans previously used, one of the big double shackles shown by the plate being used to join this span to the bridle legs. The weight of this chain span was about fifteen tons and of the part of the bridle over the edge of the dock about five tons. The 8-inch wire line from the *Brutus* was shackled into the end of this chain span and the *Cæsar* put in a new double 15-inch manila span be-

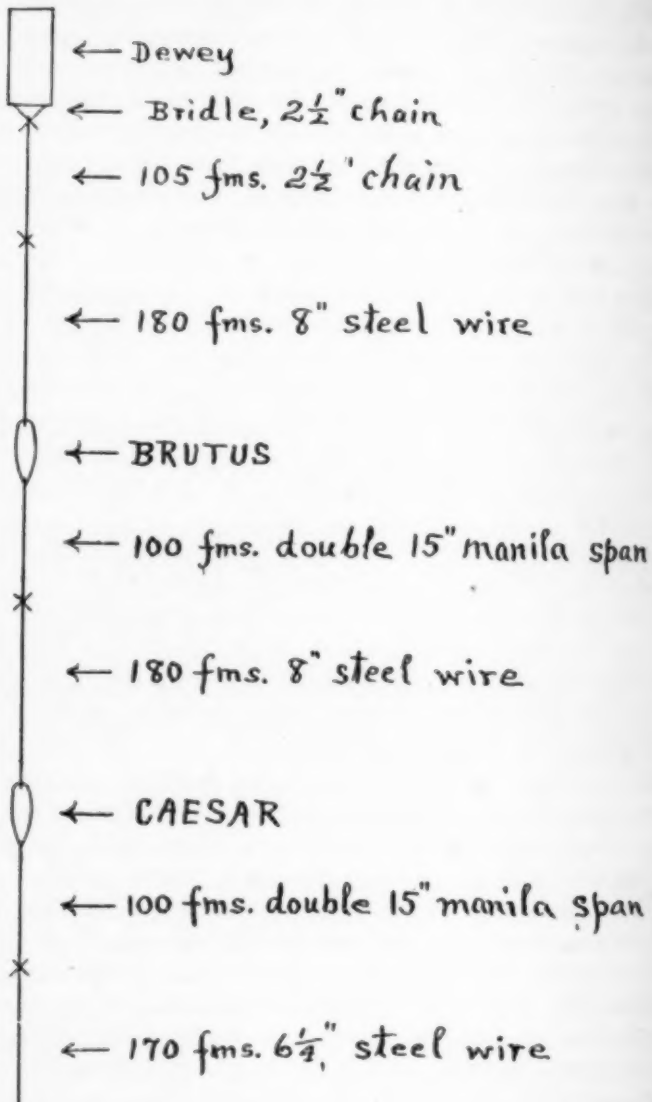

← Dewey
← Bridle, 2½" chain
← 105 fms. 2½" chain
← 180 fms. 8" steel wire
← BRUTUS
← 100 fms. double 15" manila span
← 180 fms. 8" steel wire
← CAESAR
← 100 fms. double 15" manila span
← 170 fms. 6¼" steel wire
← GLACIER

FIG. 7.

tween her 8-inch wire and the bridle on the bow of the *Brutus*. The *Glacier* put a new 6-inch wire line on her towing engine, with a new double 15-inch manila span joined to it and secured on the bow of the *Cæsar* in the manner shown by Fig. 3. The whole train, made up as described, is outlined by Fig. 7.

A delay occurred in getting underway at Suez May 3 from a peculiar cause. The *Brutus* ran her 8-inch wire to the dock, where it was shackled into the chain span just described, and then went ahead, the dock heaving up her anchor, which was at the opposite end, at the same time. No amount of pulling was able to start the dock and the natural supposition was that the heavy chain and bridle, overboard in less than five fathoms of water, had fouled something on the bottom or had settled into the mud deep enough to form an effective anchor. The *Potomac* was pushing behind the dock and the *Cæsar* was eventually put on ahead of the *Brutus*, but with no result except some broken lines. Finally, after four hours of such fruitless endeavor, it was discovered on the dock that their anchor had picked up a big mooring chain which was holding them very securely! It was soon cleared and the expedition started on its voyage, but it was after dark before the *Glacier* got her boats and working party on board from the dock and was thereby delayed from getting into the tow until daylight the next morning. As soon as the dock was well underway the *Potomac* parted company to return to the United States; without much regret I imagine, as her small size had converted the hardships of the voyage into genuine suffering for her crew.

Though something less than half the distance from Chesapeake bay to the Philippines had now been accomplished, a point is reached in this narrative from which the remainder may be quickly told, and will be no longer a succession of tales of storm and breakdowns. With full confidence in the new train of towing gear, the three ships steamed ahead at full power and got results that would have been surprising in mid-Atlantic. Though for the most part calm and hot—bad weather for steaming—the run of 1200 miles through the Red Sea was made in eleven days and the same rate was maintained through the Gulf of Aden, where we experienced both favorable and adverse currents, making 123 miles one day and 97 another, though making the same revolutions of the engines both days in smooth water. We passed the

eastern end of Socotra May 21, about twenty miles south of us, and entered the open ocean, where no monsoon was found; only a swell and light breezes from S. S. E. and south, and, after we had advanced about 200 miles, occasional passing showers with light variable winds. Sighted Minicoy June 1 when we were passing through the eight-degree channel.

It is within the observation of the oldest inhabitants about Bombay that the southwest monsoon very rarely sets in during a period of moonlit nights. It was full moon this year on the sixth of June, the night our expedition was passing Point de Galle, and the monsoon had not yet broken, nor did it break until the moon quartered, a week later, and considerably later than the annual average time. Lecky, than whom there is no better authority, ridicules the idea that the moon has influence over the weather, but nevertheless the southwest monsoon broke in the Indian Ocean in 1906 about two weeks later than usual, and if the full moon period at that time did not delay it, what did? That two weeks' respite was the making, or rather the mending, of our fortunes in the towing squadron. From Ceylon to the north end of Sumatra there is a pronounced easterly current and with that and fine towing weather combined to help us we broke all previous records several days in succession, and one day, June 9, we reached our high-water mark with 152 miles. Very early the morning of June 13 violent rain squalls, with fresh to strong breezes, fell upon us from S. S. W., raising a heavy sea and throwing the ships into more uncomfortable motion than we had felt for two months. This was probably the overdue "burst" of the monsoon, but we were so nearly beyond its reach that we did not care whether it was or not. The next day we passed Pulo Bras and into smooth water behind Sumatra in the Strait of Malacca, where good weather favored us again.

Just after midnight the morning of June 21 we arrived off the port of Singapore and felt quite proud of ourselves, for we had hauled the refractory dock 5000 miles in forty-eight days without a breakdown and with only a few brief delays. These were occasioned by one funeral, a Chinese seaman having died on the *Brutus*, and by the necessity of slowing down about once a week to allow boats to visit the *Glacier* for fresh provisions and ice. A leaking joint in the feed pipe of the *Glacier* obliged her to stop for about two hours, which stopped the whole flotilla, as she was

towing at the head of the column. A similar accident on the *Cæsar* did not compel us to stop, as she stopped her engines and the other ships kept on at full speed, carrying the *Cæsar* along like a dead locomotive in the middle of a freight train. In the course of the forty-eight days the *Glacier* was out of the towing line fifty-two hours, having gone into Colombo for coal and to exchange mails.

In entering port at Singapore two accidents occurred that had no serious results, but each came close to being a disaster. It so happened that we arrived there at the change of the moon, with its accompanying spring tide and darkness, and the hour of our arrival was unfortunately such that we struck an unusually strong tide running with us close to the port. We rounded Raffles light shortly before midnight of an extremely dark night and the next hour the flotilla made nine miles, half of which was due to the tide, but this was not a welcome help, as the immediate problem was to stop and not to make speed. According to previous practice the *Glacier* cast off and sheered out of the column to heave in her lines. Soon afterward the *Cæsar* slowed down to reel in some of her wire hawser and immediately things began to happen. The *Brutus* closed up on the *Cæsar* so quickly that she had to stop and back, and the dock, driven onward by the powerful tidal current, swept up dangerously close to the *Brutus*. In this situation, which was surely a critical one, both colliers went ahead at good speed, the *Cæsar* to escape from the *Brutus* and the latter to get away from the huge mass of the dock looming up in the darkness astern. When they got opened out they found the dock adrift, the big double shackle between the chain span and the dock's bridle having carried away when the lines came taut.

I believe all this happened because the people on the colliers did not realize in the darkness how strong the tide was running and therefore did not think of the possibility of the dock having a progressive movement of its own. Nothing in our previous experience with it suggested anything but a sudden stop whenever the towing force was removed. At any rate, they were all fortunate to get out of it without a serious smash-up, for the results of six months of hard sea-faring came near to being marred there within as many minutes. The water was about 50 fathoms deep where this occurred: the dock was therefore allowed to drift along with the tide until it got into about 25 fathoms, when it was

brought up with two of the 4000-pound mushroom anchors on the end of 180 fathoms of 6-inch wire line, the *Glacier* and *Cæsar* standing by. The break, occurring where it did, left the *Brutus* with fifteen tons of chain overboard on the end of her wire tow-line, and this she could not heave over the rail with all the power of her winches. In such predicament she steamed into the port dragging the long and heavy chain over the bottom, and stopped when she got to a good place without being obliged to anchor, the chain over her stern attending to that. Later, when the dock had arrived and anchored, the *Brutus* dragged the chain into proximity, when it was unshackled and the end taken to the dock by an 8-inch manila line, after which it was an easy matter to get it on board with the powerful steam capstan of the *New York*.

Heaving in the 180 fathoms of wire with two anchors on it proved a hard task for the dock and it was almost 9 A. M. before that structure was underway again, being in tow of the *Cæsar* only. The *Glacier* went into port and anchored and the *Cæsar* brought the dock in an hour later and anchored it about 300 yards off our port beam. Signalling the dock to let go the tow-line, the *Cæsar* went ahead with starboard helm to turn out of the narrow space between the dock and the *Glacier*. A considerable tide was running, which swept her down toward our bow and we veered chain to 120 fathoms to make more room for her. When she was nearly pointed to pass clear of us it suddenly developed that her tow-line had not been let go from the dock, and this coming taut over her port quarter neutralized the helm effect and she just missed ramming us on our port side forward. As it was, she fell across our bow, carrying away our bowsprit, which fell overboard, and damaging her bridge and awning stanchions and boat davits considerably. The actual injury to the ships was so small that we could have gone to sea and resumed towing the dock within two hours, but it was a narrow escape from a bad accident, as the *Cæsar* had way enough on to have cut the *Glacier* down had she struck her in the hull.

A week was spent at Singapore to give liberty to our crews while coolies coaled the ships. The men had earned a rest and extended shore leave, which they got, without regard to conduct class, and for which many of them showed appreciation in the characteristic manner so well known to commanding and executive officers. The Chinese crews of the colliers did not abuse their

privileges and did not make any extra work for the police force on shore. We left Singapore the afternoon of June 28 and entered the China Sea for the last leg of our long voyage. The southwest monsoon was now well established and for several days we had favorable winds varying in force from light breezes to moderate gales, with much rain, thunder and lightning, through which we made good progress as the prevailing direction of the wind was nearly astern. Then followed lighter and more variable winds with smooth seas and considerable blue sky, which period was taken advantage of to clean and paint our upper works and get the ships into presentable condition for entering port.

It was the typhoon season and as we had acquired the habit of looking for trouble I think that some of us saw unusual colors at sunset and long plumes of cirrus clouds radiating from a point in the horizon almost any time we looked for such things. But if we thought we saw them, no harmful results followed, and at daylight July 10 we saw what we wished to see, the entrance to Subig Bay close ahead and a correspondingly satisfactory distance from the Patuxent river. At noon the day before, which ended the last whole day's run we were to make, the observed position gave 111 miles made good, which is mentioned because of its coincidence with the day's run our first whole day out from Chesapeake Bay. Entering Subig Bay, we received a noisy welcome of steam whistles and sirens from the *Ohio, Rainbow,* and some smaller naval vessels. Then we "shelled off" from the end of the tow and hauled in the heavy water-logged lines for the last time, the *Glacier* first and then the *Cæsar,* leaving the *Brutus* to take the dock to the designated anchorage off Olongapo, which was reached and the dock's anchor let go at 8:55 a. m. We fully expected to moor the dock and strip it of the temporary towing appliances before being done with it, but an order had been received from the Navy Department that we were excused from any more dry-dock duty as soon as the dock was anchored, for which we were thankful, as we had had enough to satisfy us. After being only about four hours in that port we got underway and left for Cavite, leaving the dock behind with no great regret at thus suddenly terminating a long fellowship, and with full confidence that we shall recognize it if we ever see it again.

Passages	Miles made good	Time d. h.	Daily Averages miles.
Patuxent River to Las Palmas	3,844	56 23	67.56
Las Palmas to Port Said	2,849	32 00	89.03
Port Said to Suez	87	1 11	58.78
Suez to Singapore	4,992	48 7	103.38
Singapore to Olongapo	1,317	11 17	112.47
Totals	13,089	150 9	87.03

Ship	Coal consumed	Cost of coal
Glacier	5,136 tons.	$27,224
Brutus	3,664 "	12,594
Cæsar	3,238 "	14,164
Dewey	923 "	4,088
Totals	12,961 tons.	$58,070

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

SABRE AND BAYONET.[1]

By CIVIL ENGINEER A. C. CUNNINGHAM, U. S. Navy.

Until within a couple of years the sabre and bayonet had become to be regarded in the United States Service as practically obsolete weapons. Probably their estimated value as weapons reached its lowest ebb during the Boer War, for in that conflict the Boers were not only seldom within hand reach, but seldom even in plain sight.

A tendency to underestimate the sabre and bayonet in the United States is a natural one. For many years our only conflicts were with hostile Indians who were so successful in evading personal encounter that the sabre and bayonet came to seem encumbrances. Improvement in firearms has been the strongest argument against hand to hand weapons, for with increased rapidity and accuracy of fire it has become almost suicidal to venture into the open when near the enemy.

In the United States the sword has never been a part of every man's personal and necessary equipment as it was in more ancient times in Europe, and consequently there has been no individual sentiment and association connected with it. The bayonet is a comparatively modern weapon, having originated in Bayonne in the latter part of 1600 and has no individual association to create sentiment in its favor.

Notwithstanding the increasing opinion that the sabre and bayonet were obsolete, the influence and counsel of a few wise minds had saved them from extinction. The fact that a bayonet could be used as an intrenching tool helped save that, and that

[1] The illustrations of this article were posed for by the author, the new army cavalry sabre and the new army rifle with 16-inch bayonet being used. Harris & Ewing, photographers.

other nations retained the sabre for, at least, what had been accomplished with it, may have had some influence in the case.

The results of the Russo-Japanese War have entirely changed the prevailing ideas regarding sabres and bayonets, for this conflict was between combatants who did not evade hand to hand encounters when opportunity offered. It was early discovered in

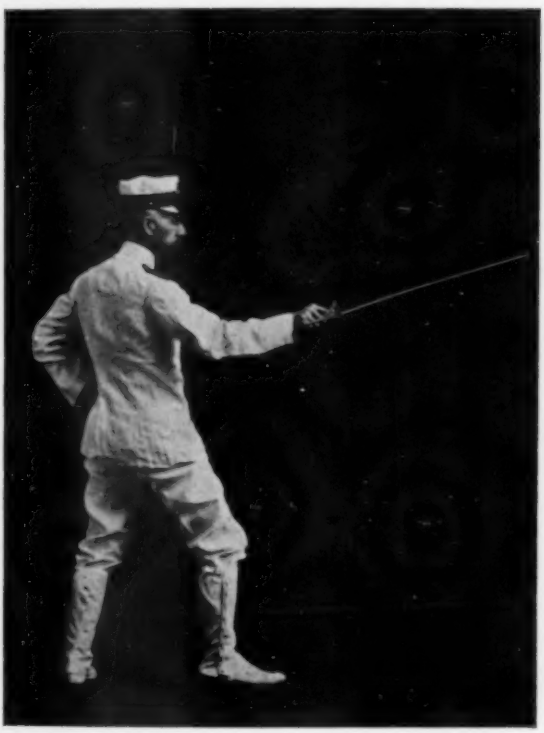
POSITION OF GUARD.

this war that the retarding effect of rapid and accurate gun-fire did not exist under cover of darkness, and that hand to hand conflicts could be precipitated at night. When such an affair occurs the side that is the best armed and trained for it will be victorious.

It is quite generally regarded that cavalry, as such, will be of little importance in modern wars, but of considerable, regarded as mounted infantry. Perhaps it will be well not to pass final judgment in this case also, as long as horses exist. In com-

pleting the rout of an enemy and effecting captures, cavalry certainly becomes of the first importance and much of this work can be done with the sabre while it continues to exist.

The bolo of the Philippino seems to the American an outlandish weapon and his method of using it without formulated system. The bolo, however, is to be classed with the sabre and the Philip-



POSITION OF ENGAGE RIGHT.

pino's method is what is known to swordsmen as "timing." Timing is common to all savages, and especially those who use shields; it is the fundamental principle of swordsmanship of taking advantage of an opening, and when highly cultivated becomes extremely dangerous to a less trained adversary. The advanced swordsman not only "times" on opportunity but makes opportunity by parries and feints.

In spite of the lessons of the Russo-Japanese War the United

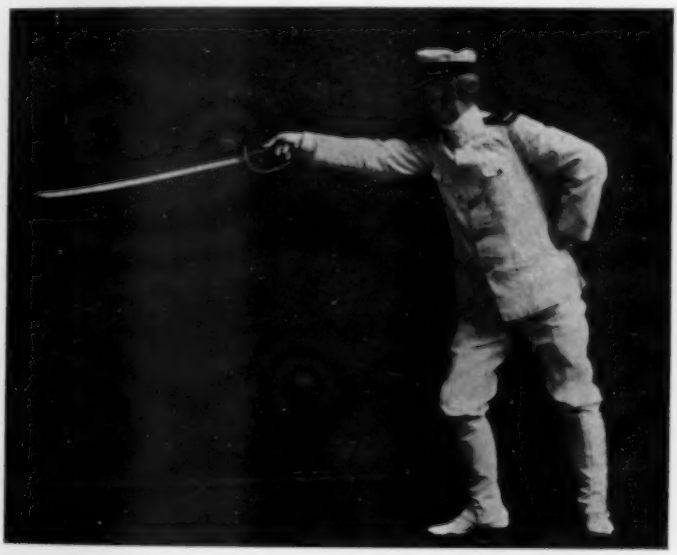
States army bayonet was about to degenerate into a simple prod called a rod bayonet when President Roosevelt, after personal investigation, called a halt and ordered the design of a bayonet of the first class. With great thoroughness he at the same time ordered the design of first class swords for both the army and navy. A joint board left the matter in the hands of the army where it remains at present.

POSITION OF ENGAGE LEFT.

The development of the bayonet is interesting. At first it was purely a prod inserted in the muzzle of a musket when action became too close to permit of further loading; a variation and improvement on this type was a dagger with a hollow handle that went over the muzzle of the musket. The next stage was the fixing of the prod to the muzzle with two side rings which permitted the musket to be fired with the bayonet fixed. This

naturally developed into what we know as the triangular or Springfield bayonet in which the prod is carried farther from the muzzle by a shank.

As the prod or stabbing type of bayonet is not the best sort of a hand weapon, the last general development took the form of the knife and the sword bayonet. At first bayonets were fixed on the side of the musket barrels, but as accuracy of fire developed it was recognized that this tended to turn the barrel in aiming, and they are now fixed on the bottom. In developing the bayonet



CUT AT THE HAND. EXTENSION WITHOUT LUNGE. EXECUTED FROM THE POSITIONS OF GUARD, ENGAGE RIGHT, OR ENGAGE LEFT.

into a hand weapon as well, undue dimensions and weight have at times been given to it, but in good proportions and design not only an efficient hand weapon is secured, but a better bayonet as well. During the development of the bayonet it has been sought to combine with it at times the properties of various tools, but these efforts have made no permanent impression.

There had been no development in American swords until President Roosevelt's order. The United States cavalry sabre was of uncertain origin and antedates the Civil War; it had a long, heavy, dull blade, effective only in rough assault, and entirely

unsuited to defensive purposes or true swordsmanship. The new army sabre has a much lighter and better balanced blade which is sharp on the point and front edge, and part way down the back; it is well hilted, has the most effective grip yet designed for a sabre, and is well suited for both attack and defense. There are three lengths of blades for various service.

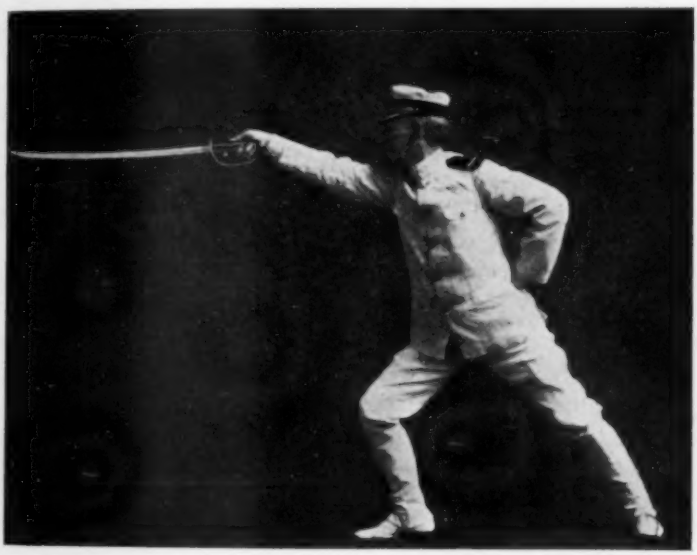
The United States navy cutlass dates from the Civil War. It

PARRY AND AVOID HAND CUT; ATTACK MADE FROM LEFT ENGAGEMENT. FROM THIS POSITION A RETURN ATTACK MAY BE MADE IN RIGHT HIGH.

has a short heavy blade suited to rough assault and defense. The hilt is very poor; it is over guarded on one side with a half-basket and much exposed on the top and other side; the grip is of such a shape and size that, combined with the guard, the weapon can only be used effectively after the manner of a club. It should be replaced with the new army sabre having the shorter blade.

Officers' swords in both the army and navy and marine corps have degenerated into little more than ornamental badges of authority, and in the navy they have been abandoned for even this, except on occasion of ceremony, having been replaced by the revolver. In the army hereafter, officers will use the new sabre as issued to the general service.

The fact developed by the Russo-Japanese War that sabres and bayonets may still be of some use and are of too much value to be abandoned, leads to the consideration of their most effective use.



CUT AT THE HEAD OR FACE WITH LUNGE. EXECUTED FROM THE POSITIONS OF GUARD, RIGHT, OR LEFT ENGAGE.

The history of the sword shows that its skillful use has been mostly controlled by sword masters who have associated themselves into various schools. The art of fencing has been made complicated and tedious and its acquirement a slow and laborious process. Even yet there are some who may believe that there were secret and special attacks which gave their possessors great advantage. Fencing has gradually freed itself from its mysteries and complications, but is still a matter for sword masters and the fencing hall, and no strictly military system free from these matters has as yet been developed.

A military system of fencing should be simple, effective, and quickly and easily learned. Its transmission should be possible without a fencing master, and its principles so simple and correct that even one not greatly skilled can teach others to become skillful.

No disparagement of existing standard methods or schools is intended whatever. They are most excellent and admirable, but are truly for the expert specialist in his natural field, the fencing hall. The more highly specialized fencing becomes the greater are the number of rules limiting what may be done and the area of attack and defense. The more intricate the art the less does the tool used resemble a true weapon of warfare, and the more nearly alike must they be, until we reach the slender French foil, the use of which in its greatest perfection makes only point touches on less than half the torso.

In warfare there are no rules and limitations nor choice of adversaries, weapons or place, and it takes but little thought to see that fencing hall work does not alone fully fit one for the field.

Anyone who has carefully watched a fencing contest has noted that when hard pushed even the most accomplished fencers will resort to any movement that will defend themselves, and that an aggressive man with an unrecognized and apparently wild and irregular attack is harder to keep off than an expert. These irregular touches are easily healed in the fencing room with the balm that "they are atrociously bad form;" when made with a bolo by a savage they need a surgeon. With these ideas in view the following systems are submitted:

THE SABRE.

A MANUAL AND EXPLANATION OF ATTACK AND DEFENSE WITH THE SABRE FOR FOOTMEN.

This system is based on what may be called a natural or instinctive method, and the expansions which would most naturally follow from experience and observation. It is instinctive to strike with a club and a matter of cultivation to thrust with the end. It is instinctive to first dodge a blow and next to turn it aside.

In this system the attacks are made by cuts and thrusts, the cuts developing planes or warped surfaces, and the thrusts developing lines, straight or curved. In this respect all systems are similar.

The defense is made by the partial development of a variable cone, or cones, the base being away from the body. In other systems the defense is made by the development of planes or warped surfaces after more or less intricate and unnatural motions.

No originality is claimed for this cone of defense, simply due and just recognition. The experts of all systems will resort to the cone of defense when hard pressed and their own system fails to be effective.

When a line or surface of attack is developed and is brought to intersection with a cone of defense before landing, the defense is effective and may be repeated or the attack reversed. The cones of defense are developed away from the body.

The attack and defense are distinguished as right and left, high or low.

From this general description of the proposed system the following manual and explanations will be readily comprehended and mastered by even those who have given no great attention to swordsmanship.

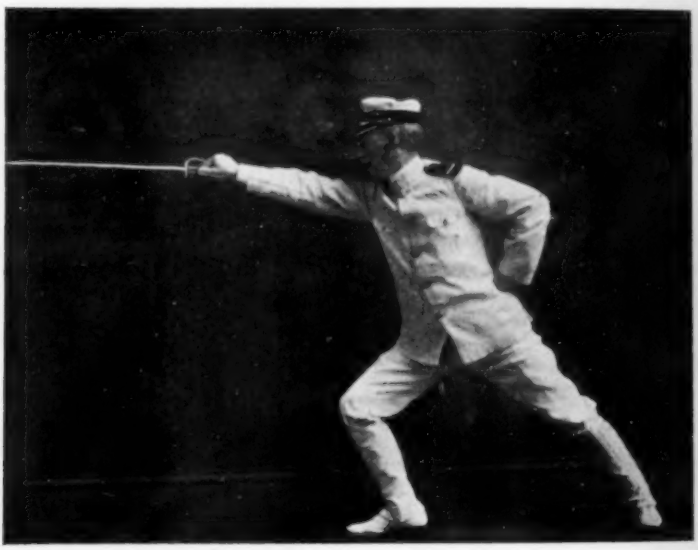
In the following manual no foreign or technical words are used. Opponents are designated (1) and (2) and the command for execution is the conventional word, Hep. The instructor will first name each motion, or combination of motions and then explain and illustrate the same. As a class progresses, explanations and illustrations will become less necessary, and the correction of errors and perfecting of motions will become the principal concern. The fewer the men in a class the greater the attention that can be given to each individual. With beginners it is preferable that individual instruction should first be given by more experienced men, if possible. The motions having been executed by (1) and (2) should be reversed and executed by (2) and (1). At the completion of each motion the position of guard should be resumed without further command. The fact should be recognized from the start that the work is of an individual nature and that the perfection of the individual is the object desired. Correct understanding and execution should be the aim rather than entire uniformity and the reduction of the matter to a mere form of drill. With the exercise of patience and encouragement the matter will soon become of interest to the pupils and rapid progress will result.

The men are first deployed, by infantry tactics, in two lines facing each other at a distance of about 10 feet, and with about 6 feet between the couples engaged, sabres at carry, order, or porte arms. With beginners the motions are executed deliberately at first until understood and perfected; speed is then increased as rapidly as possible.

Sabre Manual.

(1) and (2), guard (front or rear), Hep!

Half face to left; advance the right foot or retreat the left,



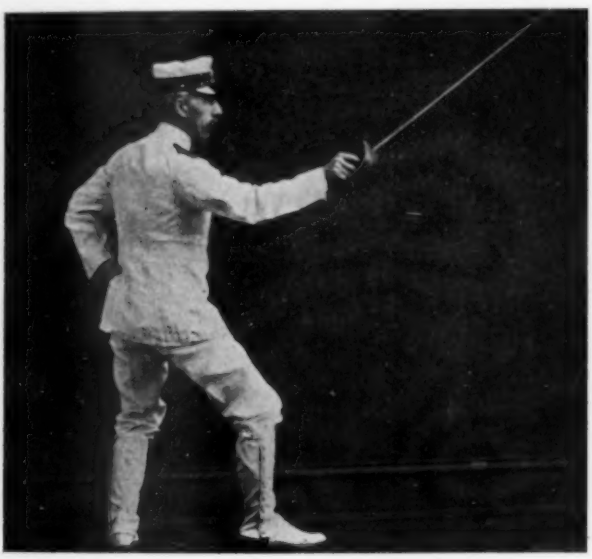
CUT OR THRUST RIGHT HIGH, WITH LUNGE.

according as an open or close distance is desired, until the heels are about one foot apart and approximately on the line connecting opponents; feet at an angle of not greater than ninety degrees; sabre held firmly in right hand with thumb on back of grip; edge down; right hand about height of waist; elbow about six inches in front of hip; point at height of chin; left hand on hip and left elbow well back. An unknown opponent may take this or some other guard, but from this position you are always ready

for action. Take account of the ground you are on and its peculiarities. From the time you are on guard and within reach watch carefully and constantly your opponent's sword and sword arm; do not watch his eye.

(1) and (2), engage right (or left), Hep!

From the position of guard the edges of the sabres are turned to the right (or left) and brought into contact, the blades crossing at about the outer third of their length. (1) takes the initiative, passing his blade over that of (2) if the latter's blade is low, or under if it is high. In right engage the hand is about in

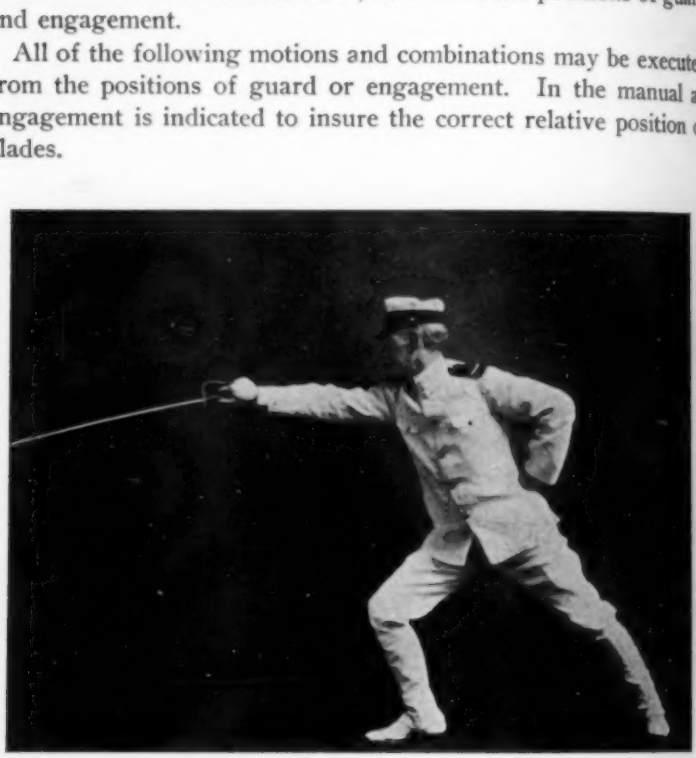


RIGHT HIGH PARRY; BEGINNING OF PARRY FOR AN ATTACK AT THE HEAD OR FACE.

line with the right side of the body and the blade inclines slightly to the left; in left engage the hand is about in line with the left side of the body and the blade inclines slightly to the right. Right engage is the standard initial postion of the fencing hall; it closes one line of attack and the feeling of the blades gives some intimation of intended action. An unknown opponent cannot be forced into a continuous engagement, if unwilling. A continuous engagement will greatly dull the edge of a sharpened

sword. Before making an attack it is essential to know on which side of your opponent's blade your own is located, and this is the main reason for an engagement. Opponents should accustom themselves to attack and defense, both from the positions of guard and engagement.

All of the following motions and combinations may be executed from the positions of guard or engagement. In the manual an engagement is indicated to insure the correct relative position of blades.



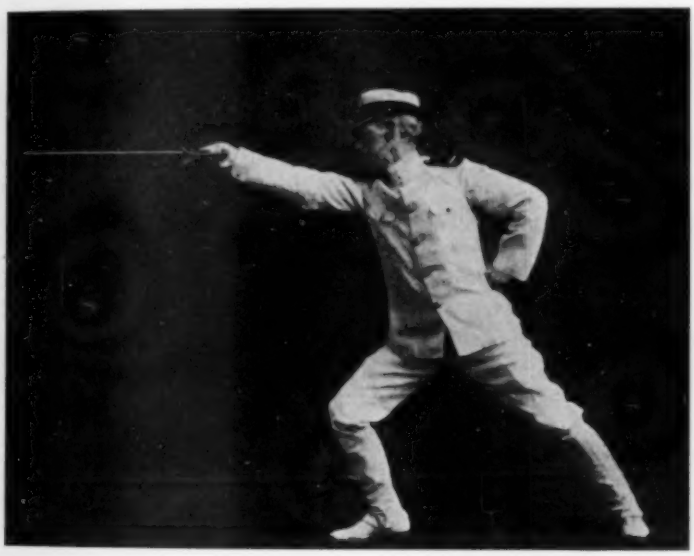
CUT OR THRUST RIGHT LOW, WITH LUNGE.

(1), cut at the hand (down, right, or left); (2), parry or evade, Hep!

Executed from the positions of guard or engagement. (1) makes a quick snapping cut at the hand of opponent without raising the point. (2) raises his point to receive the cut on cross plate at the same time turning the knuckle guard to the side from which cut comes. When well executed this cut comes so quickly and with so little indication that it will generally have to be avoided by quickly drawing the hand back out of reach.

This hand cut is frequently prohibited and never encouraged in

the fencing hall, as it tends to neutralize the more complicated and interesting sword play. The guards on practice sabres are also very much larger and more extensive than the service conditions of a military sabre will permit, and in consequence of these conditions very few amateur fencers give any consideration to attacking or defending the hand. To a military fencer disabling his opponent takes precedence over a showy display of swordsmanship, and the sooner and easier he can be put out of action the better. This hand cut should be frequently practiced



CUT OR THRUST LEFT HIGH, WITH LUNGE.

until the fencer has it so well fixed in mind that he is always prepared to deliver or receive it.

From the guard on an unknown opponent's sword, some idea of his method may be inferred. If his sword has little or no guard he will not be likely to offer opposition, will dodge in preference to parrying, will keep a good distance and make rush attacks when an opening is presented. If his sword has a fair or good guard he is more likely to offer opposition, parry instead of dodging, and make direct attacks. In this manual both methods have consideration.

(1) and (2), engage right, Hep!

(1), cut (or thrust) left high with lunge; (2), parry left high, Hep!

From the right engagement (1) passes his blade over the point of opponent's blade, turning the edge to the left, extending the arm and leaning forward with the body. Any part of the opponent's left side from the head to the waist is attacked. The point attacked remaining open, the right foot is quickly advanced to increase the reach, the left leg being extended at the same time. The advance of the right foot, or lunge, should be moderate and not in excess of a point from which the position of guard can be quickly recovered. By keeping the right foot back of the knee a stronger spring can be made in recovering. The left foot preferably remains flat and in place. The passing of the blade and the extension is one continuous motion instantly followed by the advance, or lunge, if it appears that the attack will be successful. Whether the attack is a cut or a thrust will be a matter of choice and judgment. The point attacked remaining open as the lunge is made, a cut may be converted into a thrust by moving the point in. Thrusts, as a rule, are more effective and deadly than cuts, but require more accuracy and skill, and do not demand as strong a parry.

As (1) passes and extends his blade (2) will turn his edge to the left moving his hand to the left line of the body at the same time; the attack being continued (2) will make a conical motion with his blade engaging the blade of opponent and throwing it off and downward. During the contact of a successful parry the attacking blade is no longer under the complete control of its owner.

Whether an attack is successful or not the one delivering it will resume the position of guard as rapidly as possible.

Cuts in general are preferably delivered with a quick snapping wrist motion, and with a sharp blade are very effective. Full arm and swinging cuts may be of advantage at times when a sure opening has been secured, but as a rule they are strongly indicated to the opponent and give time for evasion or the possibility of placing a quick stop attack before the swinging cut has landed. As the motions become familiar and understood the commands for execution may be abbreviated, the foregoing, for instance, becoming: Engage right; (1) attack left high, (2) parry, Hep!

(1) and (2), engage right, Hep! (1), cut or thrust left low with lunge; (2), parry left low, Hep!

Executed in a similar manner to left high, except that the attack is directed to a point from the waist downwards. It will seldom be advisable to attack below the knee. In the parry the hand should be carried lower than in left high, and the attacking blade may be carried well down by extending the arm and depressing the body, thus causing a large opening on the opponent for a quick return attack. When this parry is well made on a

LEFT LOW PARRY; FINISHED EXTREMELY LOW FOR A STRONG RETURN ATTACK OR DECEPTION IN RIGHT HIGH.

strong attack, the attacking blade is quite helpless for an appreciable time. The strongest parries are made with the portion of the blade nearest the guard, and should be so made as far as possible.

(1) and (2), engage left, Hep!

(1), cut or thrust right high with lunge; (2), parry right high, Hep!

(1) and (2), engage left, Hep!

(1), cut or thrust right low with lunge; (2), parry right low, Hep!

These motions are executed in a similar manner to those previously described for the left side. If an opponent holds an unusually high guard the attacks in the low lines, both right and left may be made by passing the point under instead of over the opponent's blade.

(1) and (2), guard, Hep!

(1), cut at the head or face with lunge; (2), parry right (or left) high, Hep!

(1) extends and makes a short quick downward cut from the wrist at the head or face of opponent.

(2) parries high right or left according to which side of the attacking blade his own may be on. This attack is used immediately upon coming on guard when the distance is moderate or short and may frequently be successful from the element of surprise in it where the opponent may be of a more deliberate nature. When the distance becomes short and there is no engagement existing this attack is also indicated.

(1) and (2), engage right, Hep!

(1), cut or thrust right low with lunge; (2), parry right low, Hep!

From the right engagement (1) lowers his point directly on the right side for an attack anywhere below the guard of (2). This attack is particularly indicated when the opponent holds a high guard. In parrying (2) will move his hand to left, if necessary, to insure being on the inside of the attacking blade.

(1) and (2), engage left, Hep!

(1), cut or thrust left low with lunge; (2), parry left low, Hep!

The movements are executed in a similar manner to those just described for the right side.

The motions so far described are single attacks and parries, and must be well understood before more complicated work can be made successful. An unskilled opponent may frequently be disabled by a single attack, and the ability of an unknown opponent may also be judged by one or two cautiously executed single attacks. With a skilled opponent a single attack will seldom be successful and also invites an immediate return attack. In consequence a skilled swordsman generally begins an attack with a deception, as follows:

(1) and (2), engage right, Hep!

(1), deceive left high and cut or thrust right high with lunge; (2), parry left high and right high, Hep!

(1) starts a left attack with vigor and all the indications of completion, but without lunging. As (2) takes the left parry (1) changes his attack to the right and delivers it with a lunge. The success of this attack lies in securing a strong full parry from the opponent. As soon as it is seen that the parry will be made the attack is immediately changed before a contact is secured, the attacking blade being shifted under that of the opponent. When the attack is changed to the right (2) parries right if possible. A skilled swordsman will seldom be deceived into a full parry on a false attack. The sense of time and distance becomes so strongly developed that the parry is executed at the last instant necessary for protection. This deception is executed in a similar manner from the left engagement.

(1) and (2), engage right, Hep! (1), deceive left high and cut or thrust right low with lunge; (2), parry left high and right low, Hep!

Executed in a similar manner to the foregoing except that the real attack is directed to the low line instead of high. The parry is even more difficult for the final attack than in the preceding. This deception is executed in a similar manner from the left engagement.

Deceptions in General.

Unless an opponent responds well to a deception there is little use of continuing the attack. It being found that the opponent is fairly well versed in one deception, two may be attempted in different lines before the real attack. More than two deceptions are of little practical value. The object is, of course, to utilize the time that an opponent takes to parry one line to attack him in another.

When an opponent uses strong single attacks a skillful adversary will continue the necessary parry into a return attack which may be landed without lunging, as follows:

(1) and (2), engage right, Hep! (1), cut or thrust left high with lunge; (2), parry left high and return right high (or low); (1), parry right high (or low), Hep!

(1) executes a full left attack, (2) executes a left parry carry-

ing opponent's blade well down and without any pause in the motion executes a right cut at the most exposed part of adversary. The thrust is not used for this return as it involves a loss of time, and the opponent is also within easy cutting distance. (2) executes a right parry, if possible, before or while resuming guard. The motions are executed in a similar manner from the left engagement. The abbreviation for above command would be: Engage right; (1) attack left high, (2) parry and return, Hep!

These simple attacks may be executed with a view to securing a return attack from the opponent and then hitting him with a counter return, as follows:

(1) and (2), engage right, Hep! (1) left cut or thrust high with lunge, (2) left parry high and return right high, (1) right parry high and return left high, (2) left parry high, Hep!

(1) executes a full left attack but only with sufficient strength so that a return is invited; (2) executes a parry and right return which is delivered with strength; (1) remains in lunge, parries right and continues is to a strong left return; (2) parries left, if possible. The motions are executed in a similar manner from left engage.

The combinations of attacks, parries, deceptions, returns and counter returns that are possible are exceedingly numerous, but the principles of all are covered in the preceding descriptions. The practice of these motions between opponents will soon indicate the importance of a proper distance, and the manner of controlling it may be taught at any time as follows:

(1) and (2), guard (front or rear), Hep! (1), advance with right foot; (2), retreat with left foot, Hep!

(1) advances the right foot with caution about its own length and quickly follows with the left to position of guard. (2) carries back the left foot about its own length smartly and quickly follows with the right to the position of guard. The advance and retreat are indicated simultaneously here for practice only. The advance is used for securing an easier hitting distance. An attack should always be watched for as the advance is made. An advance may be covered by threatening attack at the same time. A retreat is used for opening a dangerously close distance or for avoiding an attack when there may be uncertainty of parrying it.

As it is taking the user out of reach it is made quickly and freely. Retreating to avoid attack should not become a habit in preference to parrying.

(1) and (2), guard (front or rear), Hep! (1) advance with left foot; (2) retreat with right foot, Hep!

(1) brings the left foot against the right and advances the right to position of guard. (2) carries the right foot back against the left and then the left back to the position of guard. This advance and retreat are for a different purpose than the preceding. The advance is a more cautious one and less likely to be observed. It may be reversed at any time before the right foot is moved. It may be converted into a lunge as soon as the left foot is placed, thus greatly increasing the previous reach, and may be the only way of reaching an opponent who insists upon a long distance. The retreat also more quickly carries the right leg out of hitting distance. It need not be completed, but the right foot may again be advanced to position of guard.

(1) and (2), guard (front or rear), Hep! (1), advance passing left foot front, (2), retreat passing right foot rear, Hep!

(1) passes the left foot to the front and left of right and quickly brings the right to position of guard, or attacks with lunge. (2) passes the right foot to the rear and right of left and quickly brings the left to position of guard. This advance and retreat cover still more ground than the preceding. The retreat is particularly valuable for avoiding a reckless attack.

(1) and (2), guard (front or rear), Hep! (1) and (2), spring to the rear, Hep! This is executed as a quick jump as far as may be without losing the balance or destroying the position of guard. It is used in emergencies or when surprised beyond control of the situation.

The mastery and understanding of the motions and movements described should readily fit the swordsman for undertaking or receiving more complicated attacks. The ordinary systems of swordsmanship do not encourage originality or independence and in this respect are at fault.

Special Cuts, Parries and Evasions.

As a sabre is sharpened down the back some six or eight inches, some valuable attacks may be made with this edge, and such

attacks should also be watched for and guarded against. If an opponent offers a feeble opposition in engagement his blade may be pressed aside and the attacking blade advanced inside his guard, making a cut with the back edge on the face or neck.

From the right engagement, especially if the opponent holds a high guard, the blade may possibly be passed under his guard and a hooking cut made on his wrist or forearm with the back edge.

Attacks on the left from the right engagement may at times be made with the back edge and point without turning the hand from the position of guard. Attacks on the right from the left engagement with the back edge should be sparingly used as they leave the arm much exposed to counter attack.

A high left attack may sometimes be parried with the back of the sabre without turning the hand, and permits of a very quick return attack in right high.

As a general rule all attacks should be parried. A high horizontal cut, however, may sometimes be evaded by quickly lowering the body on both legs, or by carrying the left leg backwards to the position of lunge, a low return attack being delivered at the same time. The proceeding is attended with some risk and should be used sparingly and with caution.

Practice Assault.

Practice assaults should be made from the very beginning of the instruction under the supervision of the instructor. They should be limited to the motions learned and understood, including all that has been previously acquired. In no other manner can a competent swordsman be developed. The instruction by manual gives a previous knowledge of the attack that is to be met; in the assault the attack can only be judged and inferred as it is made and developed. A competent defense becomes instinctive and without formulated thought for which there is no time, and as it is far more difficult to acquire than the attack, it should be carefully cultivated. The practice assault should sometimes be made with the service weapon, blunted and dulled, to accustom the adversaries to its weight, balance and feel; ordinarily, wooden sabres or more flexible practice sabres may be used; masks, gloves and padding are essential, not only for safety, but for the full development of the swordsman who will not work correctly when exposed to uncomfortable hits.

General Remarks.

Distance.—The distance between opponents is very important. If it is too short parries are very difficult. If too long, hits are easily avoided. Cautious swordsmen generally keep within long hitting distance and, if necessary, close when attacking. Generally, keep out of easy hitting distance, especially if the opponent has a longer weapon. If you have the shorter weapon, the opponent's attack should be induced and a hit made with a return attack while the opponent's body is advanced, if possible. If the opponent keeps a long distance watch him for a rush attack; if he seeks to constantly close the distance, it may be possible to keep him off by threatened or false attacks.

Attacks.—The attack has the advantage against a poor opponent, and is at a disadvantage against a good one. One or two cautious attacks should be made to judge an opponent's skill. Return and counter return attacks are more likely to secure a hit on an opponent of some skill than direct attacks. A good swordsman is seldom hit on direct attack; deceptions are used to induce a parry and the attack is then changed to an unprotected line. When the opponent parries with his point well down or up, or attacks with swinging or circular cuts, watch for an opportunity to cut his sword arm or hand. When an opponent's guard is held high, attack or deceive, in the low line, and when held low, the reverse. An opponent's blade may be pressed to one side to induce an attack on the other side.

Defense.—Whatever system or style your opponent uses, his object is necessarily, to avoid your attack and make a hit with his point or edge. If he uses a shield of any kind a direct attack on him should not be made. With a stronger opponent or one with an unknown method be cautious about engaging blades. Use parries as much as possible, but be always ready to retreat or dodge an attack. Attacks on the left side may be received on the back of an emptied revolver held in the left hand and a return attack made with the sabre at the same time. Do not make a full, strong parry until certain that a positive attack is delivered. No complicated attack can be made without your co-operation in parrying.

The Sabre Against a Fixed Bayonet.—A short sabre is of more advantage against a fixed bayonet than a long one, as the opponent

cannot be reached on simple attack in any event, but only after getting inside his guard. A short sabre is a "quick" weapon and the best adapted to parries. Avoid engagement against a fixed bayonet, as the opponent has great leverage for throwing the sabre out of line. Keep only within long hitting distance of the bayonet. When the opponent lunges with the bayonet it is more easily thrown out of line with a parry and an opportunity may be made to close in and make a hit. It is possible to turn a bayonet out of line by strongly engaging with the sabre near the hilt; by then closing in and grasping the gun barrel near the muzzle with the left hand the opponent may be at once disabled. The opponent's left hand on the gun barrel is his most exposed and unprotected part and should be attacked whenever possible.

Actual Combat.—In single combat the principles of swordsmanship may be fully applied, but the recklessness and rush sometimes used in the practice assault may result in defeat. Superior parrying ability may decide a single combat as there will be seldom more than one hit necessary. When a good hit is made there will be no return from the opponent, such as are frequently made in practice assaults. In a melee, judgment alone must direct the proceedings of the swordsman, but a good knowledge of the principles of swordsmanship will be greatly to his advantage.

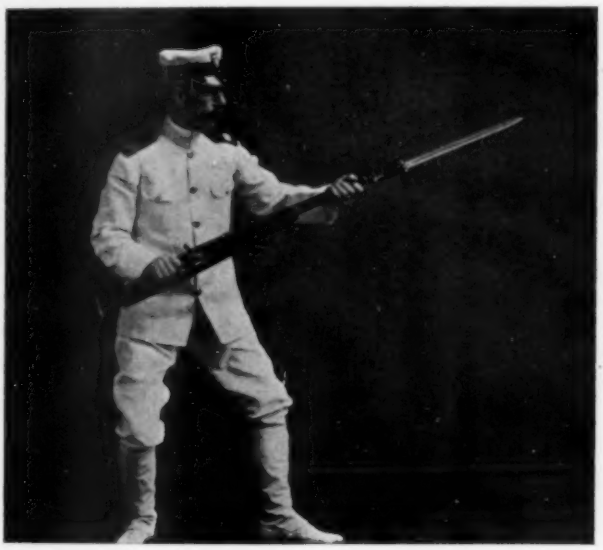
THE BAYONET.

Considered as a fencing weapon, a rifle with a fixed knife bayonet is a sort of crude combination and compromise between a quarter-staff, a spear, and a two-handed sword. It has all of the defects and a few of the advantages of these weapons, and if it were primarily or solely a fencing weapon there would be no excuse for its existence. The combination, however, is an incidental one, and in extension of the principal use of the rifle, and as such becomes of great importance.

The invention and adoption of the bayonet changed the military tactics and equipment of armies. In the face of muzzle loading, inaccurate, and slow firing muskets, bayonet charges have decided the result of engagements. Troops without high courage and strong motives cannot stand before a bayonet charge if it comes within effective reach, and the latest facts are that it can be brought within effective reach under cover of darkness and silence, at least.

It has been previously pointed out how the practical military use of the sabre has been retarded by the monopolizing of the art of fencing by various schools of swordsmanship. Any one who in studying fencing has made a hit on his fencing master by some unexpected attack "not in the system," will recall the state of moral terror to which he was reduced for such proceeding, and the punishment he probably received "according to the system" for what was actually a success and to be encouraged.

As an actual fact the practical use of the bayonet has suffered



POSITION OF GUARD, SHORT.

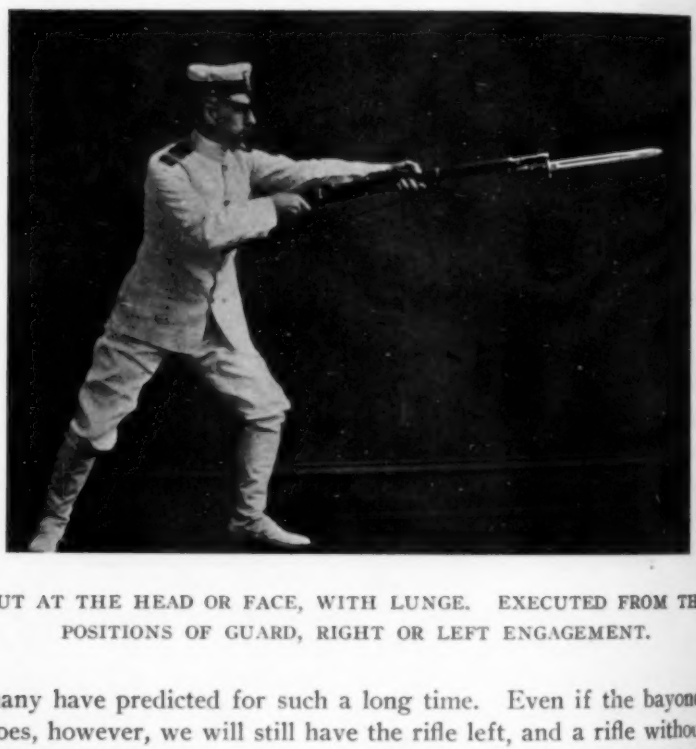
more from the hands of military men than the sabre ever did from fencing masters; not the military men of to-day, but of the days when an attempt to move a body of troops while at order arms would have been considered an appalling display of inefficiency.

The manner in which the use of the bayonet has suffered has been in the attempts to reduce it to a purely military drill. A little thought will at once show that appearances have taken precedence over efficiency and practical use. In addition to this, some experts of evidently unusual acrobatic power have at times

introduced motions as ridiculous as they were impossible for the average soldier to perform.

Although the knife and sword bayonet have been in existence for many years, no generally used manual has ever yet recognized and provided for the use of the edge of the bayonet in cutting.

As long as we have the bayonet the most efficient work of which it is capable should be cultivated with it. The present popularity of the bayonet may be only a "flare up" before extinction, as so



CUT AT THE HEAD OR FACE, WITH LUNGE. EXECUTED FROM THE POSITIONS OF GUARD, RIGHT OR LEFT ENGAGEMENT.

many have predicted for such a long time. Even if the bayonet goes, however, we will still have the rifle left, and a rifle without a bayonet, when handled according to good bayonet manual, is a very formidable weapon.

In submitting the following bayonet manual full recognition is given to the point and edge, and especially the effectiveness of the latter. A strong similarity to the preceding sabre manual will be noted and the matters that are in common to both will be repeated as little as possible.

A MANUAL AND EXPLANATION OF ATTACK AND DEFENSE WITH THE FIXED KNIFE BAYONET.

Opponents are designated (1) and (2), and the command for execution is the conventional word "Hep!" The motions having been executed between (1) and (2) should be reversed between (2) and (1).

At drill or practice opponents are deployed in two lines facing each other, according to infantry tactics. The distance between opponents should be about four paces and between each pair of opponents sideways not less than three paces. The exercise may begin from order arms or porte arms with bayonets fixed. With beginners the motions are executed slowly at first until understood and perfected, after which speed is increased. The exercise is severe and fatiguing and caution should be used not to overdo it.

Bayonet Manual.

(1) and (2), guard full (or short), Hep!

Half face to right; carry the right foot back about once its length on the line joining opponents, feet forming not greater than a right angle. Right hand and thumb closed around small of stock, butt to the right and entirely clear of forearm in order that a free and unhampered motion may be had. For full guard the left hand grasps the piece a short distance in front of the center of gravity; for short guard the left hand grasps the piece a few inches from the muzzle; the right hand grasp is firm and full; the left hand grasp is firm but always ready to shift from one guard to the other. With the short guard the piece may be slipped back and forth in the left hand in attacking and parrying. Barrel of piece to left and front edge of bayonet to right; right hand opposite and at height of hip; point of bayonet at height of chin and piece pointing slightly to left.

Attacks or parries may be made from either the full or short guard. The short guard is the less fatiguing and the stronger for parrying; a longer attack can be made from the full guard; changing guards quickly should be practiced. In both guards the left hand and arm is more or less exposed to attack which should be constantly watched for. When the left hand is attacked slip it back quickly, if at short guard, moving the piece

back with both hands to avoid the attack and resuming guard as quickly as possible. Watch constantly for a chance to attack your opponent's left hand.

Your opponent's position of guard will not greatly differ from the foregoing in any event. If his bayonet is pointed only and without an edge you will have a great advantage. Observe as far as possible the nature of the ground you are on and its obstructions. Practice should be had on various kinds of ground

CUT OR THRUST LEFT HIGH, WITH LUNGE. EXECUTED FROM POSITIONS OF GUARD OR RIGHT ENGAGEMENT.

for experience. From the time your opponent is on guard within reach watch constantly his bayonet and piece.

(1) and (2), guard right (or left), Hep!

Swing on the ball of left foot to the line attacked following quickly with right foot to position of guard. Retain piece at position of guard making a strong sweep with the change of line.

(1) and (2), guard rear Hep!

Face to rear swinging to the right on ball of left foot, and bringing right foot to position of guard. If clear of friends make a strong sweep with piece in turning. If near friends

or in close ranks bring piece vertical before turning and resume guard when faced to rear. When attacked in single rank, front and rear, odd numbers face front and even numbers face rear.

(1) and (2), move right (or left), Hep!

To move right advance the right foot a short distance to the right and follow with the left to the position of guard. To move left carry the left foot a short distance to the left and follow with the right to the position of guard. The movements are used

CUT OR THRUST RIGHT LOW, WITH LUNGE. EXECUTED FROM POSITIONS OF GUARD, RIGHT, OR LEFT ENGAGEMENT.

to secure a more favorable line for attack or to avoid the opponent's attack.

(1), circle right (or left) around (2); (2), circle left (or right) in position, Hep!—Halt!

The opponent may be encircled by a series of right or left moves so made as to maintain the distance. Better ground may be obtained in this way or a more favorable light. The opponent's left parries are the weakest and an encircling to the right may enable a strong attack on his left. If encircled by opponent turn left or right on ball of left foot to keep him in line, following with right foot to position of guard.

(1) and (2), butt front, Hep!

Bring the piece vertical in front of right shoulder, barrel to the rear. Strike forward and upward with the right hand. The blow may be delivered low or high according to distance of opponent. This blow may be delivered after opponent has grasped your piece near muzzle.

(1) and (2), butt left, Hep!

PARRY RIGHT HIGH ATTACK.

Bring the piece vertical in front of body, barrel to right. Strike left and upward with right hand.

(1) and (2), butt right, Hep!

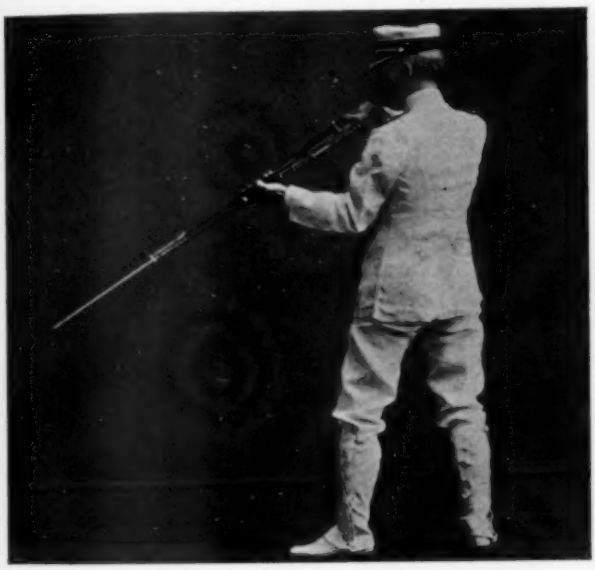
Bring the piece horizontally in front of the body, barrel down, butt to right. Strike to the right with both hands. Butt right may also be executed directly from the position of guard by striking out with the right hand.

(1) and (2), butt rear, Hep!

Face to rear turning to the right on balls of both feet. Piece horizontal, barrel down, and butt to rear. Strike to rear with both hands. The blow may be delivered high or low. A strong

butt to the rear may also be delivered without turning to the rear on the feet.

The butt is used for sudden and close attacks when the bayonet cannot be brought into line. The grasp of the right hand is not changed; the left hand may be at long or short guard. When distance becomes too short to even use the butt, powerful blows may be struck with the piece held upright in both hands.



PARRY LEFT LOW ATTACK.

(1) and (2), engage right, Hep!

From the position of guard, full or short, opponents engage right by bringing the right or front edges of bayonets together (1) taking the initiative. This is the standard engagement with a fixed bayonet. It is not necessary that the bayonets should touch, but it is of extreme importance to know on which side of your guard the opponent's bayonet may be and the contact gives assurance of the position. If the engagement is made below the bayonets it indicates a dangerously close distance, and there is a chance of fouling the bayonet guards. In the position of guard and the engagements the point of bayonet should be kept about on the center line.

(1) and (2), engage left, Hep!

From the right engagement either opponent may pass to the left engagement. The safest and quickest change is by passing the point underneath the opponent's and making a new contact with the left edge or back, the general position of guard remaining the same. If the opponent's point is low the bayonet may be

BUTT LEFT. USED FOR A SUDDEN AND CLOSE ATTACK FROM LEFT.

passed over his point by drawing the piece backward somewhat to prevent raising your own point too much out of line. If the opponent refuses any engagement whatever, be sure on which side of your guard his point is at all times.

(1) and (2), engage right, Hep! (1), left cut or thrust high with lunge; (2), left parry high, Hep!

(1) passes his point over or under the guard of (2) and extends his bayonet to reach him at some point on the left side from the head to the waist. The grasp of the hands is not

changed and the barrel of piece is kept to the left. If a cut is intended the pass is made outside the opponent's body and an inward stroke made with the back edge of bayonet. If a thrust is intended the pass is made as closely as possible to opponent's piece without fouling the bayonet guard. As the extension is made the body is leaned forward to assist the reach and the left

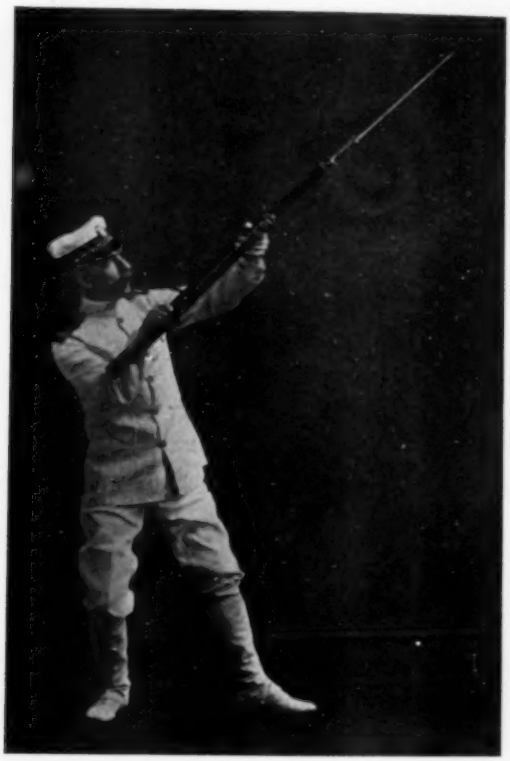
BUTT REAR. USED FOR A SUDDEN AND CLOSE ATTACK FROM THE REAR.

foot advanced to a short lunge at the same time. The lunge should not be so long as to prevent a quick resumption of guard. After the attack is delivered resume guard as quickly as possible whether a hit has been made or not.

As the attack is delivered (2) moves his point quickly to the left a sufficient amount to keep the point or edge of (1) off his body; the motion is principally effected with the left hand.

(1) and (2) engage right, Hep! (1), left cut or thrust low with lunge; (2), left parry low, Hep!

Executed in a similar manner to left high, except that the point is passed under the guard of (2) and the attack is directed from the waist downward. As the attack is delivered (2) lowers his point sufficiently to meet the piece of (1) with the bayonet or



RIGHT HIGH PARRY FOR ATTACK FROM HORSEMAN.

upper part of barrel and with a left movement keeps the attack off the body. In lowering the point to make parry a slight circular motion to the right will insure the piece of (1) being on the left. When an attack is delivered at about the waist-line there is the choice of high or low parry. In all parries the piece should be kept well clear of the body, and moved up, down, or sideways by a motion of both hands.

(1) and (2), engage left, Hep! (1), right cut or thrust high with lunge; (2), right parry high, Hep!

Executed in a similar manner to the left high attack. Attacks on the right bring the full front edge of bayonet into play. Attacks on the right are stronger than on the left as are also the parries. As the attack is delivered it is met by (2) with a motion of the piece to the right. Less motion with the point is required than in the high left and the entire piece may be moved slightly to the right.

(1) and (2), engage left, Hep! (1), right cut or thrust low with lunge; (2), right parry low, Hep!

(1) lowers his point below opponent's piece and attacks in low right in a similar manner to the attack in low left, (2) parries right low in a similar manner to left low, except that less motion of the point is required and the whole piece may be moved slightly to the right.

(1) and (2), engage right, Hep! (1), right cut or thrust low, with lunge; (2), parry right low, Hep!

(1) lowers point and attacks directly in low right, (2) parries low right.

(1) and (2), engage left, Hep! (1), left cut or thrust low with lunge; (2), parry left low, Hep!

(1) lowers point and attacks directly in low left; (2), parries low left.

(1) and (2), engage right (or left), Hep! (1), cut at the head or face (with or without lunge); (2), right (or left) parry high, Hep!

If the opponent's point is held low or far out of line, a cut at the head or face may be possible. The barrel of piece is turned upward bringing the front edge of bayonet down and a short quick cut made at the head or face. The attack may be accompanied with a lunge, (2) parries the cut with right or left high according to which side of the guard it is delivered on.

(1) and (2), engage right, Hep! (1), deceive left high and cut or thrust left low with lunge; (2), left high and left low parry, Hep!

(1) starts a left high attack at opponent, a cut being preferably indicated as it requires a stronger parry. As soon as (2) starts

a left high parry, (1) drops the attack to left low and preferably delivers as a thrust which is quicker, closer, and harder to parry. (2) starts a left high parry; when the attack is changed to the low line the defense is converted into a left low parry; in lowering the piece a slight curve to the right will insure being on the inside of the attack.

(1) and (2), engage left, Hep! (1), deceive right high and cut or thrust right low with lunge; (2), right high and right low parry, Hep!

The attacks and parries are executed in a similar manner to those on the left.

(1) and (2), engage right, Hep! (1), deceive left low and cut or thrust left high with lunge; (2), left low and left high parry, Hep!

(1) and (2), engage left, Hep! (1), deceive right low and cut or thrust right high with lunge; (2), right low and right high parry, Hep!

(1) and (2), engage right, Hep! (1), deceive right low and cut or thrust left high with lunge; (2), parry right low and left high, Hep!

(1) and (2), engage left, Hep! (1), deceive left low and cut or thrust right high with lunge; (2), parry left low and right high, Hep!

These attacks and parries will be readily understood from the preceding explanations. An experienced man is seldom hit on direct attack, especially in the high line. False attacks, or deceptions, are therefore used to create a wider opening and detract attention from the point finally attacked. No great force is put into the deception in order that the attack may be quickly changed. Parries should be given no more motion or strength than necessary in order that deceptions may be quickly met.

(1) and (2), engage right, Hep! (1), left cut or thrust high with lunge; (2), left parry high and return right high; (1), right parry high, Hep!

Having received and parried a left high attack, a return attack is at once made in high right while inside opponent's guard. The return should be made as soon as a safe parry has been secured and while the opponent is still advanced. When a return is con-

templated the more the attack is thrown out of line the surer the return. The counter attack is parried in right high by first passing the point under opponent's piece to the left side. The parry may be taken while still advanced by drawing the piece back, or may be taken as guard is resumed.

(1) and (2), engage left, Hep! (1), right cut or thrust high with lunge; (2), right parry high and return left high; (1), left parry high, Hep!

(1) and (2), engage right, Hep! (1), left cut or thrust low with lunge; (2), left parry low and return right low; (1), right parry low, Hep!

(1) and (2), engage left, Hep! (1), right cut or thrust low with lunge; (2), right parry low and return left low; (1), left parry low, Hep!

These attacks and parries will be readily understood from the preceding explanations. Return attacks should be carefully cultivated, as they are difficult to parry and the opponent is within easy reach and much exposed. The return attack can be made a continuation of the parry and there is no previous warning of its delivery. Return attacks, threatened or actual, prevent the opponent from making attacks in some other line. The combinations of attacks and parries so far explained are about the limit of practical application for the fixed bayonet.

The following foot motions may be taught at any time during the instruction in the manual.

(1) and (2), guard, Hep! (1), advance with left foot; (2), retreat with right foot, Hep!

If out of hitting distance the space may be closed by advancing the left foot about once its length and quickly following with the right to position of guard. This should be done with caution, as it may be met with an attack. An advance may be covered by threatening an attack.

The distance may be dangerously close and need opening. Carry the right foot back and quickly follow with the left to position. The retreat may be made and a parry executed at the same time. If the retreat is made for safety it should be long. A short retreat may be made to induce an opponent within easier hitting distance.

(1) and (2), guard, Hep! (1), advance with right foot; (2), retreat with left foot, Hep!

If the opponent is out of hitting distance the right foot may be brought up to the left just before the lunge is made, thereby greatly increasing the reach. The advance with the right foot is a cautious one, as it may be reversed before completion in case of a sudden attack. If used simply for closing distance, move the left foot forward to position as soon as the right is advanced.

In the retreat the left foot is closed against the right and the right quickly moved back to position. This retreat most quickly carries the leg and lower part of the body out of hitting distance. The closure of the left foot, only, may be made to avoid a low attack and the foot again advanced to position.

(1) and (2), guard, Hep! (1), advance passing right foot front; (2), retreat passing left foot rear, Hep!

In the advance the right foot is passed to the front and right of the left, care being taken not to assume a cramped position. In the retreat the left foot is carried to the rear and left of right in the same manner. Follow with the other foot to position of guard. The movements are used to quickly open or close distance.

(1) and (2), guard, Hep! ((1), leap to front; (2), leap to rear, Hep!

Spring forward or back on both feet, being careful to retain guard and balance. The movements are used as an element of surprise or to avoid reckless and unfamiliar attacks.

General Remarks.

Distance.—The distance between opponents is very important. If too close, parries are difficult and if very open, attacks are ineffective. The matter of distance is complicated by the exposure of the left hand in the position of guard and in attack. The safest working distance is with the bayonets engaged, and with a constant readiness to advance or retreat.

Attacks.—Hits will seldom be made on an experienced opponent by direct attack, and are more likely to be secured by a a deception or counter-attack. The weight and balance of a rifle with fixed bayonet are such that complicated and intricate movements cannot be successfully attempted. The point of bayonet should be kept in the line of attack as much and as nearly as

possible. Cuts with the knife bayonet can be made very strong and dangerous and their use in deceptions and counter-attacks will necessitate parrying on the part of opponent. It is sometimes possible to press an opponent's piece to one side and make a direct attack inside his line of guard. If the opponent uses a system of defense in which the hand grips are not secure, or in which the piece is held in insecure positions in attacks and parries, or the point moved much out of line, it is not difficult to hit him on a deception or counter-attack, or even knock his piece from his hands.

Defense.—Be always prepared for deceptions and counter-attacks. Do not over parry or parry too soon. Parry as much as possible when attacked, but be always ready to retreat in necessity. Against an opponent of unusual strength use the short guard and avoid engagement. Against a footman with a sabre be careful that the muzzle of your piece is not grasped, and hold your point rather lower than usual. The swordsman's object is to get inside your guard. Against a swordsman on a horse keep your point about the height of his belt and use the high right and left parries for his cuts and thrusts. Attack his horse at every opportunity. The horseman's strongest attack is on his right side; if you can secure any other position you have a great advantage.

Practice Assault.—Expertness in attack and defense with the fixed bayonet can only be obtained by the practice assault. Light wooden pieces with very flexible practice bayonets, covered with leather and having ball points are the only thing that can be used with safety or comfort. Suitable masks, padding and gloves should be provided. The practice assault develops originality and opponents should be allowed freedom of position and motion within safe and reasonable limits.

Actual Combat.—Against a single opponent the principles of attack and defense may be fully applied. In the charge or melee, circumstances and judgment can alone indicate the best proceeding, but a knowledge of the manual will be of great advantage.

CONCLUSION.

It is a noteworthy fact that the officers of our army and navy as a class are not swordsmen. It is still more noteworthy that the cadets of the military and naval academies take no interest

in fencing, and were not a certain amount of instruction compulsory, would never learn anything of it voluntarily. The few exceptions to this rule make it the more marked, as those who do study it aspire to win temporary distinction for themselves and their schools. The majority of those cadets who specialize in fencing at their academies do not follow up the work afterwards.

It seems strange at first thought that this should be a condition amongst a class of men, part of whose personal equipment is a sword.

Upon analysis it becomes clear. The sword instruction at the national academies begins with the French foil. The ambitions of the young men who begin this work are great, but they quickly realize that only a very limited number will ever excel at this sport, and then only after long and tedious application. Next follows an instinctive if not a definite mental analysis that the foil is not a weapon of warfare, and its method of use not applicable to any practical weapon. About the time the student has become thoroughly indifferent to fencing there follows some instruction with the sabre. Carrying on his analysis the student notes that the sabre he is instructed with has no resemblance to the one he will later wear, and that the sword of the enlisted man resembles neither of them. However little he may have learned of fencing, he has learned enough to realize that his own sword and the sword of the cavalry man or the cutlass of the blue jacket are not practical fencing tools.

Thus are spoiled a lot of fencers in the making and instead of turning out fair swordsmen *en masse*, a very small percentage of temporary specialists are developed.

These conditions will never be bettered until both the officer and the enlisted man are given a practical weapon and taught to use it in a practical way that will be of permanent value to them, as an exercise in peace, and means of aggression and defense in war. In the army such a movement has a fair start. In the navy it is still inert.

Is it not possible that these conditions largely account for the American officer's tendency to regard the sabre as an obsolete weapon?

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

PERMANENCE OF ENLISTED FORCE OF THE NAVY.

By LIEUTENANT RIDLEY MCLEAN, U. S. Navy.

NECESSITY OF PERMANENCE.

The desirability of having as nearly as possible a permanent body of men for our ships of war has probably been recognized since the formation of the navy, but before the advent of steam and modern ordnance the similarity of many of the duties performed by merchant seamen and men-of-war's-men rendered this matter of less importance than it is at the present time.

In the days of sailing ships, when recruits were drawn chiefly from our large sea-going population, the training necessary to render the merchant seaman an expert man-of-war's-man was comparatively insignificant. But conditions have changed and the duties of enlisted men have become complex, and even a thorough seaman must now undergo much training before he becomes an efficient man-of-war's-man; and, moreover, recruits are no longer drawn chiefly from our sea-faring population. The recruit of the present day must therefore be trained not only in his more complicated military duties, in infantry, artillery, gunnery, mines, torpedoes, and engineering, but must even be trained in the very elements of seamanship itself, in boating, knotting, splicing, steering, etc.

The time necessary to train a landsman to efficiency in his ordinary duties would alone require that recruit-enlistments be reduced to a minimum, but the necessities of modern gunnery training render the retention of well trained men of ever increasing importance. No ship can profitably engage in battle-practices until the individual gun-crews have been trained to a high degree of efficiency, and this elementary training requires time, labor and expense. Until this is completed the ship is not ready for battle,

and she would therefore be an element of weakness in case of war. In fact, her effective training for battle can scarcely begin until her gun-crews are expert; this applies particularly to gun-pointers, and gun- and turret-captains, but it also applies with much force to every member of the gun-crew.

The efficiency of the fleet therefore requires (1) the reduction to a minimum of the time necessary for this preliminary training; and (2) the development of the *skill of the ship* in battle firing, which latter cannot be continuous and rapid unless the pointers and gun-crews remain practically intact during the remainder of the cruise.

These two requirements can be attained only by maintaining a reasonably permanent enlisted force. In fact, regulations insuring this permanence would influence advanced gunnery-training as beneficially as the present regulations influence the training of gun-crews; and it is this that renders the subject one of great military importance.

We should therefore not conclude that conditions are satisfactory simply because we are able to keep the personnel up to the allowed complement by the use of recruiting parties, or because large numbers of applicants for enlistment are turned away daily, nor yet because permanence is somewhat improving. Instead of congratulating ourselves that the 7800 vacancies which occurred during the last fiscal year were made good by recruit enlistments, we should rather deplore the net loss of 25 per cent of the enlisted force of the navy in one year, and the consequent necessity of replacing such a number of trained men by raw recruits.

EXISTING CONDITIONS.

Before proceeding further, it is desirable to present a statement in regard to the condition of the enlisted personnel during the last fiscal year. The report of the Chief of the Bureau of Navigation, 1905, shows:

ENLISTMENTS.

Total enlisted force June 30, 1905	30,804
Total enlisted force June 30, 1904 (from 1904 report)	29,321
Increase in enlisted force during year	1,483
Total number of recruits enlisted	9,306
Net loss during year, which was filled by recruits	7,823

LOSSES.

This net loss is due to the following principal causes:	
Number honorably discharged, failing to re-enlist in four months	1,513
Number ordinary discharges, failing to re-enlist in four months	317
Total number of desirable men failing to re-enlist	1,830
Discharges for inaptitude	116
Discharges for undesirability	678
Discharges for bad conduct	492
Discharges, dishonorable	498
Discharges, physical disability	844
Deserters	3,227
Retirements after thirty years' service	5
Deaths	135

DESERTIONS.

Number of men absenting themselves without authority	4,427
Number of men voluntarily returning to service	881
Number who remained absent either permanently or until apprehended, *i. e.*, practically deserters	3,546

MISCELLANEOUS.

Number honorable discharges, expiration of enlistment	3,484
Number ordinary discharges, expiration of enlistment	445
Number discharges entitled to re-enlist	3,929
Number of these failing to re-enlist	1,830
Number of petty officers in the service	9,400
Number C. S. C. men in service, 4,897 =	16.3%
Percentage of C. S. C. men to petty officers =	52%
Percentage C. S. C. men June 30, 1905	13.4%
Percentage C. S. C. men, 1895, 1896, 1897	31%
Number men re-enlisting more than four months after discharge, 314 = about	1%

The above figures show:

(1) That it required 7823 recruit enlistments (9306 recruit enlistments minus 1483 increase of force) to maintain the force at 30,804; that is, there was a net loss during the year of 25.4 per cent over and above re-enlistments, which had to be filled by recruits.

(2) That, not counting losses due to deaths (135) and physical disability (844), which will probably remain about constant, there were 6844 vacancies, or 22.2 per cent loss of able-bodied men, many of whom had received from one to three years' training and

were just becoming of value. Nearly half of this number were deserters, about 25 per cent were undesirable or bad characters, while about 25 per cent were *prima facie* good, well-trained men whose retention in the service would have been desirable.

(3) That, though only 3227 men were marked deserters, 4427 men absented themselves from their ship or station without authority, and only 881 of them returned voluntarily, leaving 3546 who were to all intents and purposes deserters, though some of these were apprehended and brought back. The report states that about one-third of the desertions were from the rating of coal passer, and though the desertion of a coal passer is less serious than if he were a highly trained man, even these are to be regretted, and it still leaves about 2400 deserters from other ratings.

(4) That, despite the improved conditions of enlisted men and the bonus for re-enlistment and continuous service, only 16.3 per cent of the present enlisted force hold C. S. certificates; that there were only about half as many continuous service men as there were petty officers; that there was only about half as large a percentage of C. S. C. men as in '95, '96 and '97; that nearly half of the discharged men who were eligible to and desirable for re-enlistment, failed to return, and that but 1 per cent of the total strength returned after the allowed four months.

Gun-pointers.—Leaving aside the question of general permanence, let us consider the permanence of gun-pointers alone. The following table shows changes in the pointers of main-battery guns on all battleships from which the data could be obtained.

Ship.	12 or 13-inch.				8-inch.				4, 5 or 6-inch.			
	Number pointers firing record practice 1905.	Number of these who fired record practice 1906.	Number firing 1905 dropped for other reasons than being out of the service.	Loss in one year due to being out of the service.	Number pointers firing record practice 1905.	Number of these who fired record practice 1906.	Number firing 1905 dropped for other reasons than being out of the service.	Loss in one year due to being out of the service.	Number pointers firing record practice 1905.	Number of these who fired record practice 1906.	Number firing 1905 dropped for other reasons than being out of the service.	Loss in one year due to being out of the service.
Iowa.....	8	0	0	8	16	6	0	10	8	1	0	7
Kentucky..	12	10	1	1	8	7	0	1	28	25	1	2
Maine.....	8	7	0	1	..	..	..	..	22	16	1	5
Missouri...	12	11	0	1	..	..	..	..	22	15	6 (a)	1
Wisconsin.	12	6	0	..	..	..	..	..	28	17	0	11
Alabama...	12	4	0	8					28	8	1	19
Texas.....	8	3	..	5					9(b)	2(b)	..	7
Indiana....	12	3	1	8	2	9	0	11	8	0	1	7
Illinois....	12	4	0	8	..	..	..	..	28	12	2	14
Total.....	96	48	2	46	44	27	0	22	201	107	12	82

(a) 3 transferred.
(b) Qualified. No data in re those who failed to qualify.

In the above table the first column under each caliber shows the number of pointers on board who fired with that caliber of gun on any ship at record practice, 1905. The second shows the number of these same pointers who fired at record practice 1906. The third number of those who fired at record practice 1905, who have been removed from their positions for other reasons than discharge or desertion. The fourth is therefore the loss in one year due to a lack of permanence, and does not include losses due to transfer from a ship, provided the man remains in the service. The very great difference between the different ships is of course due to the fact that, as a general rule, the term of enlistment of the majority of the crew of a ship expires the same year. The percentage of loss is also larger than a canvas of the entire service would show, since some of the discharged pointers will re-enlist, but, nevertheless, after making all allowances, the data is very instructive.

This table shows that of ninety-six 12- or 13-inch pointers who fired in 1905, forty-eight fired in 1905; two were dropped from the gun-pointer class for various reasons, leaving a loss of forty-six, or 47 per cent, due to lack of permanence. Of forty-four 8-inch pointers who fired in 1905, there was a loss of twenty-two, or 50 per cent; and of two hundred and one 4-, 5-, or 6-inch pointers, a loss of eighty-two, or 41 per cent, due to the same reason.

ARE THESE CONDITIONS SATISFACTORY?

Argument is unnecessary to show that a net annual loss of 25 per cent of our enlisted force is detrimental to efficiency. If this loss were confined principally to new and untrained men, it would be less serious, but when the lack of permanence among gun-pointers is considered, the matter assumes not only an unsatisfactory, but an actually grave aspect. These are highly trained men, and as already shown, men whose individual skill must be developed before the training of the ship herself in battle firing can progress satisfactorily. To say nothing of the time, labor and ammunition expended in training the above mentioned pointers (and which must be expended on those who replace them) if the ships in the table had been fully prepared for action immediately after the Spring practice of 1905, what loss of battle efficiency would they have sustained, due to this cause alone, by the Spring of 1906?

Though doubtless some of the pointers which are in the "loss" column will re-enlist, the fact that the crews of new ships contain only the merest sprinkling of qualified pointers shows that, as a general rule, these men are probably gone for good, and that the training expended on them during the last few years was lost just as the ships were ready to utilize their skill in battle-practices.

IS IMPROVEMENT POSSIBLE?

To answer this question we must analyze our losses. They are, roughly:

Class 1. Death and physical disability, 3 per cent.
Class 2. Desertion (or practically such), 11 per cent.
Class 3. Bad conduct, inaptitude and undesirable, 5.5 per cent.
Class 4. Failure to re-enlist, 5.5 per cent.

The loss from Class 1 will probably remain approximately constant, and is not susceptible of marked improvement.

For the purposes of this discussion, Class 2 and Class 3 should be considered together, since it may fairly be assumed as probable that a large number of those discharged as undesirable, inapt, etc., are simply men who have become dissatisfied and lost interest and have either deliberately adopted this method of leaving the service, instead of deserting, or have so failed in the performance of their duty as to cause their officers to request their discharge.

These two classes, composing about 16.5 per cent of the enlisted force, probably consists of two distinct types of men.

(1) Those who are innately vicious, undesirable, or inapt.

(2) Those who are by nature really desirable men, but who have grown so actively discontented as to make them desire to leave the service.

It is of course to be expected that in any body of 30,000 enlisted men there will be a certain percentage of the first type—those naturally undesirable—but with the care taken in enlisting recruits it would seem that 1500 or 5 per cent would be more than an ample allowance to cover this loss. This would leave 11.5 per cent of the enlisted personnel as belonging to the second type—men who are naturally desirable, but who have grown actively discontented with life in the service.

This discontent must be due either to causes which are necessarily incident to life in the navy, and hence cannot be removed, or to conditions which are not necessary to efficiency, and which

therefore can be improved. If the latter, then here is one cause of loss which can be largely eliminated.

Class 4, composing about 5.5 per cent of the enlisted force, are men who have completed an enlistment and are valuable, well-trained men. Their reasons for not re-enlisting are numerous, but in general it is probable that the same reasons that cause Classes 2 and 3 to grow discontented and to desert, prevent Class 4 from re-enlisting. If these causes are not necessary to our efficiency, their removal would increase re-enlistments and hence decrease this source of loss. If in addition to this, certain active incentives to re-enlistment could be adopted, the loss from this cause would be still further reduced.

The question then becomes: Are there any existing causes of desertion not inherent in the conditions necessary to efficiency, and are there any practicable incentives to re-enlistment which could be adopted? If there are, then improvement is possible.

After several years' study of this subject, including conversations with many enlisted men concerning desertion and re-enlistment, I am convinced that many of the regulations and customs which are the most active cause of discontent are not necessary to the results we wish to accomplish, and that there are certain other practicable regulations which might be adopted, and which would directly or indirectly incite re-enlistments.

WHAT DO WE REALLY REQUIRE?

The ultimate object of all naval training is that our ships may be properly maintained and fully manned by efficiently trained crews. If these two requirements are fulfilled the ship is ready for action. Anything which aids in the attainment of these requirements, lends itself to efficiency; and, conversely, anything which interferes is inimical thereto. These two requirements demand both work and skill on the part of the personnel.

The highest degree of efficiency in any large organization will be attained only when each individual unit of the organization has been trained to a high degree of skill. What we therefore require would seem to be regulations which will facilitate the early discharge of undesirable men, before much time had been wasted on their training, and insure permanence in service on the part of desirable men. A crew can never be efficiently trained, permanence in service can never be secured, nor can the best work ever

be obtained, if a considerable proportion of the men are normally discontented.

CONTENTMENT.

The keynote of the question would therefore appear to be the contentment of the men. Why should we expect efficient work or permanent service from discontented enlisted men when it would never occur to us to expect it from discontented men in civil life? I doubt if we have given the question of the men's contentment the serious consideration which it merits. Every precaution is taken to preserve the material of the navy in a high state of efficiency; great care is exercised to maintain the physical condition of the men, and yet their mental attitude seems to have received scant consideration, though it has a greater bearing both on efficiency and on permanence than their physical condition itself. Do the conditions of naval life which are *necessary* to entire efficiency preclude contentment? I cannot think that they do, but we can best decide this point by ascertaining what are the chief causes of discontent among enlisted men.

Is it the life itself?—To a certain extent the conditions of life in the navy are distasteful. It is an abnormal life, which does not lend itself to the establishment of a home; there are certain unpleasant features inseparable from the necessary requirements of daily life on board ship, but to counter-balance these it offers many advantages which are attractive and which appeal particularly to younger men. With its constant opportunity for travel, it affords gratification to the curious and overcomes the monotony of a circumscribed existence which is so irksome to the restless; the close associations incident to the life engender good comradeship; the sports and contests create healthy enthusiasm; and, on the whole, if we but utilize the advantages it offers, and limit the unpleasant features to those which are absolutely necessary to the ends we desire to accomplish, I do not think the nature of the life itself would account for any great amount of discontent. In fact, I see no reason why the unpleasant features which are *necessary* to the life should cause more discontent among enlisted men than among officers, and I believe that the very features which cause the greatest discontent among the men would, if applied to officers, quickly create an untenable state of affairs. In other words, I believe that the features of the life which cause the greatest discontent are not necessary ones.

Is it the amount of necessary physical labor?—I think not. Naval efficiency requires work of each unit of the organization, hard, exacting work, both for the training of the crew and for the maintenance of the ship, but experience would appear to indicate clearly that men do not object to intelligent work in itself, or to interesting and useful drills. What they do object to in the ordinary routine is perfunctory drills and unnecessary annoyances which accomplish no beneficial result—and they are quick to recognize this. Even the lazy, welcome surveying duty with its accompanying hard work. Enthusiasm is manifested in the loading drills; coaling ship is no bug-bear. Though I am aware that a certain amount of purely routine work is necessary, in any military organization, if this be reduced to a minimum, I believe the work necessary to the preparation of a ship for war and her maintenance in that condition to be in themselves negligable factors in causing desertion. I believe we can get even more work than is now required of men on board ship, without it causing one desirable man to desert, provided the work is directed to an intelligent end; and work intelligently directed will give us an efficient ship if the men are interested and satisfied.

Is it inadequate pay?—Many officers have suggested an increase of pay as a means of creating greater permanence, but I doubt both the expediency and efficacy of such a remedy. I make this statement in full knowledge of the able and convincing article by Captain E. Anderson, 7th U. S. Cavalry, published in the March "Review of Reviews," which demonstrated the necessity for increasing the pay of enlisted men of the army. The pay of the enlisted personnel of the navy is far in excess, both in the lower and the higher grades, of that which he advocates for the army. Inadequate pay is not the kernel of our difficulty. Undoubtedly, if it were practicable to make a general increase of pay of three- or four-fold, permanence would greatly increase. Men could not *afford* to leave the service; but even then I do not believe the remedy would reach the real root of our trouble. It would not remove the grievances which in my opinion largely contribute to disaffection and desertion, and would therefore not really produce contentment; it would simply result in holding men who were really unhappy and uninterested in their work. But of course such an increase of pay, even if it were desirable, would be entirely impracticable. That any reasonably large increase of pay would

probably fail materially to increase permanence is indicated by the fact that the liberal extra pay of gun-pointers, though originally designed for this purpose, has failed to accomplish that result, though it has been most beneficial in stimulating enthusiasm. In fact, I think that, as a general rule, the present pay is adequate for the purpose, especially in view of the opportunities offered for advancement, and that no reasonable or practicable increase of pay would materially assist in attaining our end. The reasons for the trouble must therefore be sought elsewhere.

If it is true that lack of permanence is not due to the unpleasant features inseparable from naval life, to inadequate pay or to the work necessary to attain efficiency, to what may it be ascribed? It must be due to certain other regulations and customs; and as hard work by a contented crew will produce efficiency, these regulations and customs which cause the trouble would seem to be unnecessary, and should therefore be changed. The changes hereinafter suggested are based on the primary motives of human nature. No change is advocated which would in any degree militate against the good condition of a ship or limit the amount of intelligent drill or requisite work. The changes have for their object the increased contentment of the men. They pre-suppose that men are willing to work for the present pay if unnecessary annoyances are removed; that if the feeling can be overcome that an enlistment is a term of servitude and the ship a sort of prison; that if cruises are so far as possible systematically arranged with the idea of permitting ships to visit good "liberty ports" with sufficient frequency; that if on arrival in port men are encouraged rather than grudgingly permitted to go ashore; that if during recreation hours active pleasures can be substituted for passive inertness; in short, if "we work while we work, and play while we play," I feel confident that contentment would be engendered, efficiency promoted, and permanence of service so greatly increased, that our net annual loss would not exceed 10 per cent, and that 60 per cent of the enlisted force would have continuous service certificates.

DETERRENTS TO PERMANENCE.

From investigation of the subject I believe the questions of food, and restriction of "liberty" and money to be the chief causes of active dissatisfaction with the naval service; causes which prevent

re-enlistment of desirable men, and which frequently result in otherwise valuable men losing interest, neglecting their duty, growing dissatisfied and insubordinate in spirit, and finally deserting or being discharged as undesirable.

FOOD.

While recent regulations have undoubtedly greatly improved the fare of the enlisted man, and while it is believed that the present ration is ample for the comfort and contentment of the crew, if properly cooked and served, there is at times so little official supervision over the actual feeding of the crew that, despite the ample ration, great dissatisfaction sometimes exists. In many cases this important department is left practically in the hands of the commissary steward, and this vital feature in the contentment and efficiency of the crew depends upon his honesty, zeal, ability as a caterer and organizer of food service. Though honesty is usual, a combination of these necessary qualities is rare, and even in cases where the commissary steward possesses all of these essentials, causes of complaint are certain to occur. Complaints are frequently unjustifiable and unreasonable but it is the man's mental condition with which we are principally concerned, and as an unjustifiable grievance is as injurious to contentment as a justifiable one, I believe the men should be encouraged to submit complaints.[1]

It is believed that the dissatisfaction which is sometimes caused by the fare could be almost entirely avoided by a method which facilitates the investigation of complaints, and by adequate direct official supervision, not of the accounts, but of the details of the actual *messing* and *subsistence* of the crew. The justice of this

[1] A solution of this feature, which has been in successful operation, was the appointment by the commissary officer of what he termed a "kicker" at each table and a "chief kicker" for the crew. The kickers would submit their complaint to the chief kicker who would investigate and, if it was of importance, report it to the commissary officer. In this way complaints which neutralized each other were settled to the men's satisfaction among themselves, while justifiable complaints received proper attention. Contentment was promoted because the men had, so to speak, a "representative form of government," and the effect of the "chief kicker" (who of course should be in no way connected with the commissary department) not taking action on a trivial complaint was much less than had the same complaint been submitted to the paymaster and no action taken.

criticism is shown by the fact that while some ships live well on the allowed ration and have their food well served, others live poorly and have their food badly served, thus causing serious discontent.

That this cause of dissatisfaction *does* exist on some ships, despite what I believe to be an adequate ration, only accentuates the importance of not dismissing it with the statement that the men are universally well fed. Conversation with many enthusiastic commissary officers only demonstrates how well the men *may be* fed, but they unite in saying that without the closest official supervision, and the most efficient organization, the best results will not be forthcoming. If the food on one ship is better than that on another in the same squadron, discontent is certain to arise; or if on any ship the food is unsatisfactory in quality or quantity, the cooking poor, or the bill of fare unnecessarily monotonous, it is certain to arouse discontent, and it is the hardest form of discontent to eradicate. On different occasions last summer I conversed, incognito, with two enlisted men of the fleet, men who expected to make the service their profession, and who stated that if a man didn't get along in the navy it was his own fault; in short, men who looked on the service in its best light. I made notes of their conversation at the time, and as they expressed it, "Kickers will kick on food quicker than anything else; our food *can* be made all right, because it *is* all right on lots of ships, while other ships live rotten. If a man gets good grub he can stand a lot of inconveniences, but as soon as he *thinks* he is not getting as good food as his ration ought to give him, he gets dissatisfied, loses interest in his job, and the first thing he knows he is in trouble. If a ship is having wholesale desertions it may be due to other causes, a mean Captain, or First Lieutenant, or no liberty; but if you examine very closely you'll be pretty sure to find a good hard kick on the grub."

This then is an important question, requiring constant watchfulness. We cannot afford to have the contentment of the ship's company, and hence the real efficiency of the ship, depend on the zeal, ability and honesty of the commissary steward. His work requires the closest supervision. Existing regulations will insure that his accounts are duly supervised, but the well-being of the ship does not depend on his accounts, it depends on the results of his work; it depends on his judgment, zeal and executive ability.

It may safely be said that the commissary steward has more to do with content or discontent than any other person on board with the possible exception of the captain and executive. Is it reasonable to trust a feature of such military importance to the ability of any enlisted man? Should the messing not always receive direct supervision of a competent officer?

RESTRICTION.

The question of restriction deserves the most careful and logical consideration. When work is not creative, where it is simply service rendered, and particularly where it involves considerable physical exertion, it must necessarily be distasteful to some extent. For men performing such service, life is necessarily made up of considerable distasteful work combined with such pleasures and recreations as are attainable—the former being the price paid for the latter. This is universally true, though on shore the employee's recreation looks out for itself, and the question resolves itself to one of hours and pay; while on a ship it is a question of pay and opportunities for recreation—which means active recreation and pleasure; not simply release from drill and ship's work. If in any vocation the distasteful features are not counterbalanced by the attractive ones, a man will naturally seek other employment. Naval life necessarily has many distasteful features; and in order to get men to adopt it as a life vocation we must reduce the distasteful features to such as are actually necessary, and utilize to the fullest extent the attractive features which the life offers. Probably the most distasteful features of naval life fall under the heading of what appear to me to be unnecessary restrictions; that is:

(1) Compelling a man, once enlisted, to complete his enlistment, regardless of what may happen.

(2) Compelling a man to remain on board ship when his services are not required, either for drill work or for the safety of the ship.

(3) Compelling a man to remain on board ship for several months as a punishment for some offense.

These restrictions are distasteful in themselves, and besides, being obviously an unnecessary denial of personal freedom, they must inevitably arouse resentment, since they curtail one of the greatest sources of pleasure, recreation and attractiveness offered

by naval life, namely, shore leave. A modification of existing customs in this regard would therefore be doubly beneficial since, while removing a cause of discontent, it would add materially to the pleasures afforded by the life. At the present time a man knows that having once enlisted, he *must* serve out his enlistment or make a felon of himself; men of but short experience know that their shore liberty is largely dependent on their superior officers and on the ship to which they happen to be transferred; "poor liberty ships" are well known on every station, and are avoided even by the best men, sometimes to the point of desertion itself. I believe that this cause is responsible for at least fifty per cent of the net losses we experience, and moreover, that it reacts on efficiency by producing discontent among those who remain in the service. It is therefore of such importance as to warrant a careful discussion of each of its features.

In view of the above cited statistics of desertions, it may seem illogical to advocate a change which would permit men to leave the service, though it is believed that the attempt to force them to remain in the service is really false economy.

In the first place, the mere knowledge that it is impossible to get out of the service honorably within four years, of itself tends to make men chafe in much the same manner as would the certainty that under no condition could they leave their native city for four years. It is an ever present reminder that they are not free agents, which in the case of many men incites a constant desire to leave. If this fact does not drive a man to desertion, it looms up prominently before him when, having once completed his enlistment, he considers the advisability of again irrevocably binding himself for four years more.

In the second place, circumstances arise when a man is practically compelled to leave the service. To buy his discharge is at best a sacrifice; a sacrifice sufficient to exert all the *beneficial* restraint necessary, for if he wants his discharge enough to buy it, it will generally be found that he wants it enough to take it, if it is not for sale.

Argue as we may, service in the navy in time of peace is not dissimilar, in the minds of enlisted men, from work on shore. The men sign an agreement to serve four years; this is the same to them as any other contract. The law assists us to enforce this, as it does other contracts, but when a man desires to be relieved

from fulfilling it, our own customs place it in a different category from all other legal contracts, in that we refuse to accept a cash forfeit, but hold his person instead. It would never occur to us to require a baseball player or an actor to be imprisoned for not completing his season; he can always purchase his release. Can a man be reasonably expected voluntarily to place himself a second time in such a dilemma, and will his experience (which he will fully describe to his shipmates) not serve to prevent many other re-enlistments? Will the service performed by him during this latter period of his enlistment be really efficient?

Few thinking men would voluntarily enter an ordinarily alluring position if they knew that they could get out before four years only by making criminals of themselves. Why should we expect enlisted men to do it? Is it not reasonable to assume that this alone causes some desertions and prevents many re-enlistments? Is the refusal to permit discharge by purchase necessary to naval efficiency?

I suppose the policy of not allowing men to purchase their discharge has been adopted to prevent the loss which would be experienced from this cause. Is this not a mistaken policy? Weighing advantages and disadvantages, the only advantage is that refusal to grant discharge by purchase retains a small number of discontented men until their enlistments expire—and in their frame of mind it is doubtful whether their retention is desirable. The disadvantages are in preventing re-enlistments, creating restiveness, discontent, and dissatisfaction; in short, in creating the feeling among the entire enlisted personnel that they are "serving time." The loss by purchase will never be material, but the *principle* of invariably approving such requests except in time of war or threatened war, if definitely adopted, would, I believe, promote content, reduce desertions, and remove one of the greatest deterrents to re-enlistment.

Regulations and customs regarding shore leave.—While I believe that the adoption of a consistent policy of granting discharge by purchase would remove one of the most active deterrents to re-enlistment, I believe the feeling that the ship is in a sense a prison is the most active cause of discontent, disaffection and desertion, and I believe many of the regulations and customs restricting shore leave are unnecessary to the results we are striving to accomplish, namely, developing an efficient, well-trained naval force.

This restriction of shore leave takes two forms:

(1) Insufficient liberty, due simply to not granting frequent permission to a large number of men to go ashore.

(2) Restriction of liberty as a punishment.

These may be considered together since the general effect is the same in kind though different in degree.

Efficiency requires that at all times we have a certain proportion (say about half) of the crew on board, and that, as a general rule, every member of the crew be on board during working hours; again, circumstances on shore may sometimes render it inadvisable to permit any men to leave the ship at all; these are some of the unpleasant features necessary to naval life and efficiency, and they are requirements which must be observed. I cannot, however, believe that efficiency demands that after working hours in port, a large body of men who have absolutely no duties to perform until the following morning, be kept on board ship against their will. On the contrary, it seems to me that the very knowledge that they have nothing to do and are nevertheless kept aboard either as a punishment or frequently because it simply isn't their day for liberty, is an ever active cause of discontent which could be avoided. Officers do not regard the ship as a prison. They know that when they have duty to perform they must remain on board; they realize that a certain number must remain on board for emergencies, duty or no duty; they realize that ships must frequently cruise in waters where shore-leave is inadvisable; still they know that under ordinary circumstances when they are in port and duty does not require their presence on board, they are free to go ashore if they desire, and it is this very knowledge which accounts for an officer sometimes remaining contentedly on board for several consecutive months.

If the question of getting ashore were an ever-present thorn in the flesh of an officer, if shore leave with him were in practice an occasional privilege rather than practically a right, would not the annoyance, the uncertainty and particularly the feeling of having subjected himself to a life in which innocent pleasures were unnecessarily withheld, a life in which his freedom was unnecessarily curtailed, would not this cause a large number of officers to seek outside employment? In other words, has not the necessity of retaining a trained corps of officers forced us into the adoption of logical regulations concerning them, while the less apparent

(though ever-present) necessity of retaining enlisted men has permitted us to overlook the fact that the latter are governed by the same impulses, not to mention the obvious fact that the men, having fewer intellectual enjoyments, are all the more in need of recreation on shore.

It is a most natural feeling for men who visit foreign ports to desire to see the town. Many officers never fail to go ashore in every port, however uninteresting, if only for a few hours. These same impulses govern men, and a feeling of resentment will inevitably result if the ship visits port after port without their being permitted to go ashore. The saying "seeing Europe through a port-hole" is proverbial, and its meaning is far reaching. In the days when the present custom had its birth, I do not doubt that it was necessary, but with the class of enlisted men we now have I am convinced that it is pernicious.

The effect of forcing men to stay on board unnecessarily—and I speak absolutely only of unnecessary restriction—is twofold. As above stated, it is believed to be directly or indirectly the most active cause of desertion, of the disaffection which swells the list of "undesirable," "inapt," "bad conduct" and "dishonorable discharges," and of failure to re-enlist; but aside from this, the effect on the men who remain in the service is to be considered.

In order that men may be amenable to proper discipline and training, they must be habitually in a normal condition both mentally and physically—and of the two the mental is probably the more important. Unnecessary restriction of liberty will produce a resentful mental condition which diminishes the worth of a man as a unit in the ship's organization and lessens his capacity for submitting to discipline. On men of long service who have become resigned to this condition, the effect is possibly not great, but on young men in their first enlistment, on those from which our C. S. C. ranks must be filled, I believe this depreciating value to be sufficient in many cases to cause such a loss of interest and zeal as materially to reduce the efficiency and the value of the men.

The restriction of shore leave, to which I refer above as appearing to me not to be requisite to the efficiency of the naval service, takes form in various ways. Probably the most frequent is the deprivation of liberty as a punishment or as incidental to the punishment of declassification; sometimes because the crew has all been on liberty, and time in port does not permit another complete

liberty; sometimes because under existent conditions it is not considered expedient to grant any liberty until certain general work is completed. From whatever point of view this question is regarded, it appears evident that any restriction of liberty not required by efficiency is a detriment not only to permanence, but also to the efficiency of those who remain; that deprivation of liberty as an habitual form of punishment should be abolished; and that enlisted men should be practically under the same liberty regulations as officers.

There is one point in regard to restriction to which attention is particularly invited. It is not the *amount* of *necessary* restriction which is galling so much as it is *any* restriction whatever, which is manifestly unnecessary. At the very best, the proportion of time spent on board ship is necessarily great for both officers and men, but except when very long periods of restriction are necessary, this does not produce serious discontent; it is accepted as incidental to the life. But the *mental condition* born of the knowledge that one cannot go ashore, though his presence is not required on board, is the cause of the really pernicious discontent, because it incites a resentful spirit.

Considering existing customs, it is well known that on different ships of the same fleet, lying in the same port, one crew will get a minimum of liberty while another will get a surfeit. This is due largely to the personal ideas of commanding and executive officers, and as these ideas vary widely between facilitating "liberty" and grudgingly permitting it, the inevitable result is wide differences in liberty regulations on different ships. On some ships liberty is dependent upon classification, which in turn depends upon the characteristics of commanding officers, as exhibited in widely varying punishments for the same offense on different ships. The effect is shown by the fact that in some ships the "first-class" men will include a large proportion of the crew, while in others it will embrace only a chosen few. Aside from a different declassification on different ships, and sometimes on the same ship, meted out for the same offense, in some ships the "first-class" men go ashore once in four days and the "fourth-class" once in three months, while in others the first-class go ashore every other day and the fourth-class once a month. In some ships a man remains "fourth-class" for three months, while in others he advances one class per month. Some ships grant no

"liberty" to a man who has extra duty to perform, while others disregard this feature. Some ships have a large number of "special first-class" men who go ashore practically as officers, while other ships either do not recognize such a class at all, or maintain it at a minimum. These facts (and they are better known to men than they are to officers) do not lend themselves to contentment; on the contrary, the very non-uniformity itself, aside from the restriction *per se*, must inevitably produce dissatisfaction, because in the minds of the men this is an ever-present demonstration of unfairness and injustice. The men, on the good and the bad ships alike, reflect before re-enlisting, because they realize that this condition exists throughout the service, and that, even though fortunate on one cruise, they may be unfortunate on the next. It would therefore seem that the effects are too far-reaching to permit liberty to be entirely subject to the necessarily widely varying ideas of commanding officers.

Deprivation of liberty as a punishment.—Let us now consider the merits of deprivation of liberty as a regular form of punishment. Theoretically, punishment is the infliction upon offending individuals of sufficient pain or inconvenience to prevent the repetition of an offense and to act as a warning to others who are liable to commit similar infractions of discipline. There can be no doubt that restriction of liberty accomplishes this object to a certain extent (and the same would be true of the whipping post) but the vital question is whether the ultimate effect on discipline (and consequently efficiency) is good or bad. In other words, is it a desirable form of punishment? It is generally conceded that the most effective punishments are those which are certain and prompt. Are the men who are undergoing punishment in an efficient or desirable mental condition? A man who is suffering from a lack of sufficient food is not in a proper condition for rendering cheerful and efficient service. The same results in a modified degree may be expected if, owing to long restriction on board ship, a man is suffering from a lack of opportunity to satisfy his natural desires. To be in their most efficient condition, men must have recreation as well as food. If either of these is restricted by necessary conditions of service, men will regard it as a simple hardship, a misfortune; but if they are restricted when there is no manifest necessity, or if they are restricted as a punishment, a rebellious frame of mind is the result, for it deprives them of what

they regard as their natural personal rights. This mental condition diminishes the man's capacity for submitting to discipline, and this diminishes his worth. Therefore restriction of "liberty," which in effect is restriction of bodily or mental necessities, reacts against the discipline and efficiency of the organization while the men remain in the service, and must inevitably tend to drive them out of it at the first opportunity, either by desertion or by failure to re-enlist.

The deprivation of liberty, sometimes as high as three months, which is administered either as a direct punishment or in connection with declassification for comparatively minor offenses, is not prompt; it causes a man to undergo punishment for an offense committed long before, it creates an abnormal mental condition not conducive to efficiency, and deprives him of the pleasures which the life must offer before he will adopt it as a permanent vocation. Though it may be argued that it is nevertheless a punishment which men fear, it may be said that the object of punishment is to exert a corrective, not a punitive effect, and to inflict punishment months after the offense was committed only produces discontent. For the above reasons it would seem apparent that deprivation of "liberty" is not beneficial as a regular form of punishment, and I suggest that a uniform scale of fines would be an ideal substitute. In civil employment fines for tardiness and absence are accepted without friction, but no employer could hold his men for a day if he attempted to punish them by restricting their food or limiting their recreation after working hours. A fine is a direct summary punishment, and being prompt and complete in itself, there would be no mental resentment, and the necessary balance between the pleasures and the distasteful features of the life would be maintained. In short, it is a punishment which, while affording a restraining effect, would not arouse a sense of violation of personal rights; and in order to avoid all suspicion that fines might be inflicted for other than disciplinary purposes, I would suggest that all proceeds from fines be turned into the general mess, or preferably that they be utilized for the benefit of the crew in such manner as the commanding officer might direct.

Therefore, as a remedy for the above enumerated evils in their various forms, it would seem that the following modification of existing regulations and customs would produce the desired result, viz:

Abolish deprivation of liberty as a punishment, except by sentence of a court martial; permit men to go ashore under much the same regulations as govern for officers, namely, when their services can be spared; and substitute as a regular form of punishment a uniform scale of fines based on percentage of pay; and to further prevent dissatisfaction let the money thus forfeited by fine be turned in to the general mess and used in subsisting the crew, or expended for the benefit of the crew in such manner as the commanding officer may direct.

When (as would probably sometimes occur) certain individual fines exceeded the man's pay, then as a last resort he could be deprived of liberty or punished in other ways, but this would be too rare to be of consequence.

PETTY ANNOYANCES.

It is believed that our regulations impose, in the ordinary daily life of the enlisted man, certain unnecessary annoyances so petty in themselves as to be generally overlooked, which have a material weight in causing men to leave the service. Though these annoyances may at first thought seem too trivial to mention, their daily occurrence, the fact that they affect so large a proportion of the enlisted men, and the fact that one's habitual frame of mind, on which contentment depends, is due rather to the minor occurrences in daily life than to those of more importance, but of less frequency, leads me to mention a few of them in detail.

(a) One of the most fruitful minor causes of discontent, for example, I believe to be that of afternoon muster. This muster is required by regulations, and even commanding officers are allowed no discretion. It does not increase efficiency, and it serves daily to annoy the 30,000 enlisted men in the service. I doubt if after officers have attained the high grades and have ceased to come into intimate contact with the men, they are able fully to realize the extent of the annoyance actually created by this muster; to appreciate it fully, one must daily see the men reluctantly breaking away from their games, their nap, their reading, or frequently from their legitimate ship's work, and forming ranks in a manner which clearly shows that they realize that the muster serves no useful purpose, and in a manner which one can clearly see does not lend itself to efficiency or increased contentment. The question arises: "Does the muster serve any useful purpose?" By

its means we do ascertain the names of unauthorized absentees, but it is submitted that the unauthorized absence of men is usually discovered, reported, and the ship searched before this muster occurs, and even were this muster the only means of discovering absentees, it must be remembered that it in no way *prevents* absence; the man is simply found to be out of the ship and the muster only advances by a few hours the time he is missed and reported. True, the setting up drill and double time are carried out, but is this itself necessary? When we consider that from five in the morning until three-thirty or four in the afternoon the men are usually fully occupied in active work and drills, have they not had all of the exercise that is necessary both for their muscles and for their wind?

If this extra exercise is considered necessary would it not be better to double the amount of the morning exercise, and after the day's work is done, say at three-thirty or four-thirty, let the men have the remaining hours up to supper to themselves? What this muster really does is to prolong the working day from nine or ten hours to twelve hours, for it is the interruption, the knowledge that the day is not yet done, rather than the actual work involved, which is annoying. Even were it a sacrifice of the physical well-being of the men, the pernicious effect of this muster on their mental attitude should alone justify its omission from the daily routine.

(b) In some respect the uniform regulations are sources of extreme annoyance to the men. The regulation shoes, for example, make the entire enlistment of some men unpleasant, so much so that this constant source of petty annoyance is sufficient in itself to cause some men to leave the service. Where a certain style shoe "as per pattern" is prescribed, the only way to have the ship's crew in regulation shoes is to have them outfitted by the Paymaster. As everyone knows, feet vary considerably in shape as well as in size. It has been found by shoe factories that in order to conform to ordinary variations in the shape of men's feet, they have to manufacture shoes of any particular style in both full and half sizes and in six different widths. Further variety in shape is offered by the slight variations in the numerous styles of shoes; and in the event of a customer having feet of slightly abnormal characteristics, such as a high or a low instep, the manufacturers cater to their customers' trade to the extent of

gladly making shoes to order at but a slight increase in price, rather than risk the danger of not giving satisfaction with one of the many ready-made varieties. Such is the variety in the shape of footwear from which a civilian may select. Compare the above attention to this matter, which is forced by business competition upon manufacturers, to that which is devoted to this same point in supplying enlisted men, and remember that the large amount of time during which they go barefooted tends to make their feet harder to fit than those of the average civilian. When we fit out men on board ship we find that the paymaster carries but one style (the regulation pattern) and this in full sizes only, and in two widths,—and this only when he is provided with a full stock; while frequently, I am informed, he is unable to obtain even the above variety of shapes and sizes and consequently, through no fault of his, is not fully fitted out; furthermore, even if fully fitted out on leaving a navy yard, owing to his necessarily limited stock the most common sizes are soon disposed of and his supply shortly consists chiefly of odd sizes. In other words, under the best conditions, the paymaster carries (in the regulation shoe) only one-sixth the variety carried, in any particular style, by a large shoe firm, and frequently he is short of the most common sizes and men must, from this incomplete assortment, buy ill-fitting shoes with their own money and wear them on their own feet, simply for the sake of having every man in the crew shod alike.

It would therefore seem that for the sake of a fetich we are making many men uncomfortable and dissatisfied, not to mention the fact that should the men thus shod land for marching they would be inefficient for the reason that in not a few instances their shoes would not fit. Would it not conduce to efficiency to frame our shoe regulations with greater elasticity, requiring, for example, that the men be neatly shod in black shoes, prescribing the Blucher pattern, calfskin leather, or making such other general qualifications as may be deemed essential? The present regulations in regard to men's shoes are a source of profound annoyance to some men at all times and to all men at some time during their enlistment, whereas were the regulations more liberal, the men would be more contented, better shod, and while perfect similarity would be sacrificed, general appearance would probably be improved.

(c) The undress blue uniform, which is the habitual costume on

board ship in cool weather, is annoying in its wristband. As a proof of this all that is necessary is to inspect a working party in this uniform say at three o'clock any afternoon in moderately warm weather: it is probable that more than half of the party will have unbuttoned their wristbands and tucked up their sleeves while the other half will have rolled back the wristband. The tight-fitting wristband lends itself neither to work nor to drill. On the other hand the present blue working jumper, with somewhat shorter sleeves than at present prescribed, is a rational costume for both: the only mistake is that instead of its being the rarely prescribed "working dress," it should be the "undress blue" uniform the same as the white jumper is the "undress white" uniform. This would give the men a comfortable uniform both in blue and in white for ordinary use, thus increasing their daily comfort, while for dress we could retain the present less comfortable, but better appearing, overshirt with tape and wristband.

The above are but a few of the "minor annoyances" which, without increasing efficiency, actually lend themselves to the daily discomfort of enlisted men, and which therefore directly incite discontent in the navy.

INCENTIVES TO RE-ENLISTMENT.

If the above-explained causes that tend to diminish permanence in the enlisted personnel are changed as suggested, I am convinced that conditions in this respect would greatly improve; but there are other changes which might be made in existing customs and laws which would either actively incite re-enlistment of desirable men or facilitate the early discharge of the undesirable.

RETIREMENT OF ENLISTED MEN.

If we hope to retain permanently a large percentage of men, not only must we remove causes of discontent, but it is necessary to offer the men a career to which they can look forward—and this can be accomplished without undue expense.

The recent provision of law that enlisted men can be retired after 30 years' service, provided no man be retired who is less than 50 years old, is a step in the right direction, but its effect in the service was, so to speak, local rather than general. That is to say, it had to my personal knowledge the effect of retaining a num-

ber (probably a large number) of men with from 20 to 25 years' service, who saw the chance of retiring on three-fourths pay when they completed their 30 years. But the prospect of a reward at the end of a longer period than 10 years is not sufficient in many cases to accomplish the desired result. Thus, the promise of reward has acted definitely to retain men who had already served 20 years but has in itself probably had little effect in encouraging men with less than 20 years' service to re-enlist, though undoubtedly its general influence on such men has been beneficial.

That its effect has not been all that might be desired is indicated by the fact that only five retirements occurred during the last fiscal year, and that, though this law has been in force seven years, only 133 men are on the retired list, and continuous-service men form only 16.3 per cent of the enlisted personnel, which is almost exactly the same percentage as in 1891, and only about half of that in 1896. To reduce the age of retirement materially would be uneconomical and probably ineffective. What then is a practicable method of increasing the benefit of retirement laws? One of the objects we wish to accomplish in time of peace is not only to prepare the present naval establishment for war, but to provide a well-trained reserve personnel. In the establishment of this reserve, manifestly any man who had no physical disability and who had served several enlistments would be a valuable addition. It would seem possible, therefore, to establish a really efficient reserve in connection with the retired list, and thus by the same act accomplish the two results. This would be an economical method of attaining the desired ends, but it would of course involve some expense, but this expense could well be incurred when the advantage to be gained is considered. This would be more apparent if the value of a really efficient reserve were more constantly before us and received the consideration which its importance merits. I think the following changes in the retirement laws would increase permanence and establish a valuable trained reserve without unduly increasing the expense.

1. Allow enlisted men to retire after 12 years' service on one-eighth pay; after 20 years' service on one-third pay; after 24 years on one-half pay, and after 30 years' service (whether they be 50 years old or not) on three-quarters pay of the rating they may then be holding, all men so retired to be available for service in time of war until they reach the age of 50.

2. Allow men who have retired after 20 years' service or more, to re-enlist for non-sea-going service (except that, in time of war they would be available for service afloat); such, for example, as duty on vessels turned over to the naval reserve, on receiving ships and navy yard tugs, at training stations, as range keepers, or on ships in reserve.

3. Allow any man on the retired list who is physically qualified to return to active service in the rating in which he was retired, on his requalifying for such duties. As a retired man receives his recompense while he is retired, treat him in regard to continuous service as if retired service was neutral time. That is, the time from the date of his retirement until the date of his re-entry into active service would be treated as if it did not exist, and in regard to his continuous service he would be treated exactly as he would have been treated had he re-enlisted on the date of his retirement.

With the idea of increasing the percentage of enlistments among men who fail to re-enlist in four months, I would suggest the following:

4. Allow men to re-enlist as at present within four months and receive pay for those months, but, should a man re-enlist within one year of his discharge, give him credit for his continuous service, but no bonus for re-enlistment, and if he enlists at any time subsequent to one year after discharge, allow the time he has already served to count as retirement service but not as continuous service.

The following advantages would, I believe, result from the suggested change:

First.—The proposed modification of the retirement laws extends to young men a direct active incentive to remain in the service a reasonable length of time, with the assurance that they will be retired on a certain definite pay while they are yet young. It changes retirement from the hope of a reward in the indefinite future (which, as has been shown, fails as an active inducement to retain young men) to a reward which they realize will come in a few years, and which will serve to hold them for three enlistments. Young men are naturally ambitious, and in many instances it would be distasteful to them to feel that they have deliberately chosen as a life work a profession in which the highest position they attain may be that of chief petty officer; but on the contrary if there are several stations along their course at each of which

they may choose whether or not they will continue to the next, if the next station is not too distant, and if a reward is held out for them to continue, the result will be to retain many men whom we now lose. By this means it is believed men will be retained for three enlistments, with the intention of then retiring and entering civil life; but on retirement, finding themselves unaccustomed to shore life after twelve years at sea, and finding their retired pay small, many of them will return to service for the two additional enlistments necessary for either their retirement on one-third pay or for shore duty on full pay thereafter. After 20 years' service a man will hardly ever adopt permanent employment in civil life, but will either live on his third pay or, more probably, return to service, with the assurance that if he so desires the remainder of his duty will be on shore, and that after 30 years he will be able to retire on three-quarters pay. The proposed system therefore offers a series of constantly increasing inducements to lead them on in the course which we would have them follow. The present laws have been made rigid with a view of forcing men to stay continuously in the service until they are 50, and also with a view of making them re-enlist in four months; and the penalty for a failure to do either causes the man to lose practically all reward for his past service. Therefore the effect of these rigid laws and regulations in many cases is to prevent men from re-enlisting, rather than to encourage re-enlistment. Hope is an inherent human quality. When a man knows that he must remain in the service until he is an old man, to gain any reward from retirement laws, he will naturally try to better himself by going into civil life at the expiration of his first enlistment. Civil life is not the bed of roses which many sailors expect, but four months is frequently not a sufficient time for them to find this out, though within the first year they will frequently have encountered breakers and learned the practical meaning of hunger and want. If then the opportunity to re-enlist and receive credit for past service is still open to them, they will be more likely to avail themselves of it.

Second.—After men have retired, and gained some experience of civil life, they are still free to return. After a man has done twelve years' honorable service he is a valuable man. With his one-eighth pay as a regular income he may retire from active service to accept a position in civil life, but with disappointment ashore he will frequently return to active duty in order to gain

the benefits of the 20-year retirement, provided he knows that he will receive full credit for his past service.

Third.—The progressive system of retirement with increased pay for 12, 20, 24, and 30 years' service would encourage men to remain as at present until they have served 30 years, when they can retire on three-fourths pay. It may be noted that the general principle on which the proposed changes are based is that Americans are susceptible of being led but not driven. We know that certain traits of character exist in the average man, and the proposed changes simply enable us to utilize these traits in accomplishing our ends instead of running counter to them. Officers are held in the service in many cases because they are receiving more pay than they could immediately demand outside, but often that is not true of enlisted men, particularly of skilled mechanics, therefore in order to retain these men we must add an incentive. The hope of retirement in old age does not in itself entirely prevent young officers from resigning, therefore we cannot reasonably expect it to so affect uneducated men who do not look far into the future; hence we must put the retirement within their reach so that they can feel that this reward will come while they are still comparatively young.

Fourth.—The assurance that after 20 years' service they can either retire on one-third pay, or re-enlist on full pay for service on shore, extends to 12-year men a further incentive to re-enlist and serve two additional enlistments. The feature of guaranteeing 20-year men shore duty extends to older enlisted men an appropriate relief from the more active duties afloat, and permits us to utilize them for duty that is absolutely necessary. Hence it is economical in that it relieves the retired list of the one-third pay which they would draw were they not employed.

Fifth.—The retired list of comparatively young men would be a positive asset in case of war, for, even if many of these men do not return to active service in time of peace, they would be available in time of war and would be a most valuable addition to the naval forces of the country at that critical moment, because they would be on the rolls and subject to immediate orders. In fact, one of the greatest advantages of the proposed change is that it would form a most excellent and highly trained reserve, always available for use the moment war is declared.

Sixth.—The extension of time between enlistments offers the

same inducements for immediate re-enlistment as at present, and at the same time those who leave the service with the intention of not returning, are encouraged to re-enlist and obtain a reward for the service they have performed.

The criticism that this retired list would be too great an expense appears to me to be unsound. The navy differs from a business organization in that the only return from the money expended is the war-efficiency which is attained. Increased efficiency has therefore a certain definite monetary value. The fact that each man on the retired list would have served three enlistments, many of them five and some seven, would of itself cause an increase of service efficiency which has a definite value. But the efficiency of the peace establishment is not enough. The only reason for all of our training and expenditure is to make the war-navy efficient. Therefore a trained reserve, immediately available for service in war, would be of even greater value in increasing our war-efficiency than in promoting efficiency in the peace establishment. This being true, we should never fear that this retired list would grow too large, but on the contrary we should look with complacency on its attaining the greatest possible size, with the assurance that when war is declared we can utilize a far greater number of such men than we will ever have on our list, and at that time their value will be too great to be measured in dollars and cents.

DESERTION.

Whether it be on account of present laws, or decisions, or regulations, the fact remains that, unless a man pleads guilty to desertion, it is very difficult for any court to find him guilty, provided he voluntarily surrenders himself. It is true that recent court-martial orders differ greatly from former ones in the large number of men against whom desertion is proved, but they nevertheless contain numerous instances of men being found guilty of "absence without leave" who had been absent from their duty for months. From an administrative point of view, desertion is defined as an unauthorized absence of ten days, while from a judicial point the intent to leave the service permanently must be established. It is rarely impossible for a man to surrender himself within the above time limit, therefore if he does remain so absent, it does not appear unreasonable to place the burden of

proof on him. If a man remains absent without leave for more than ten days, it would therefore appear reasonable to consider him guilty of desertion (unless he proves conclusively that he made every effort to return) and to punish him accordingly. A man who has left his ship without permission, and remained absent for months or years, is none the less guilty of desertion because he voluntarily surrenders himself, say to escape hunger and privation. His plea that he did surrender himself does not prove that he did not *intend* at the time he left to abandon the service permanently. To accept such pleas places a premium on actions of this sort. Admiral Goodrich has aptly expressed this thought in saying, "Desertion is a crime, complete in itself, when the inculpating offense is committed." This is undoubtedly one of the most serious defects in our present naval discipline, and it should receive correction either by law or by regulation.

This could be done by giving the word "desertion" a broader interpretation and removing its present technical limitations, or by awarding very summary and severe punishment to men who are to all intents guilty of such an offense. The nature of proof which is required to establish desertion really prevents proving the offense which the law was designed to punish. Our regulations define desertion, and prescribe certain penalties therefor, but before these can be applied the law requires the practically impossible feat of proving the interior workings of a man's mind. Whatever desertion may be in the eyes of the law, if we can assign a uniform and adequate punishment to men who remain absent more than 10 days, and see it carried out, it will remove the somewhat farcical appearance which naval regulations on this subject present to the enlisted man, and in all such cases it is the worst enlisted men who benefit by those technicalities of law.

MONEY REGULATIONS.

The principle of withholding men's money, money which they have on the books, money which belongs to them by virtue of their having earned it, is subject to all of the objections that apply to the curtailment of liberty, because it is a restriction of what men justly regard as an inherent right. It is an undesirable form of punishment in that it creates a mental condition inimical to efficiency, is non-uniform on different ships and, moreover, it invites subterfuge and deceit on the part of the men more than any

other form of punishment. These objections are only alluded to, not because they lack importance, but because of their similarity to those attending deprivation of liberty. There is ground for argument that a system of fines, by which men would forfeit their money permanently, would also arouse feelings of resentment, but it is not believed that it would have that effect, provided the scale of fines is uniform and reasonable, for though such money would be forfeited permanently, the transaction would be finished and the proceeds of the fines would revert to the crew. This is not the same constant source of irritation as that caused by withholding the men's own money.

I also specially desire to question the principle of assisting men to save money, which is exhibited in many forms in our regulations. Is this logical and desirable? What are we striving to attain? Efficiency. How can we get it? By contentment and continuous service. To allow men to draw their own money as it becomes due them would certainly promote contentment; conversely, not to do so quickly incites discontent and encourages subterfuge.

Will saving men's money, by punishment, by deposit, or by other methods, increase the amount of continuous service? I cannot think so. If two men are discharged, one with $500 and another with one month's pay, other things being equal, which is the most likely to re-enlist? The one has by our own action been assisted (possibly forced) to save enough money to permit him to enter some civil pursuit; the other will probably be without money in a few days, and will be presenting himself for reenlistment. I therefore believe the general principle is wrong; for, though it may be philanthropic, its effects directly oppose our own interests. The withholding of the man's money throughout his enlistment creates discontent and a consequent desire to leave the service, while the money thus saved enables him to gratify this desire. However beneficial this may be to the man, it is not beneficial to the navy.

Inasmuch as the deposit system is already established by law, and inasmuch as it is a privilege to the men to feel that they have this means of saving money if they so desire, I do not suggest its abolition. That would be undesirable and unnecessary, for we can entirely circumvent its bad effects by simply changing the law so as to permit men to draw the money which they have

placed on deposit whenever they desire to do so—and human nature will do the rest. Similarly, it would seem to be to our interests to permit any man to draw every month all money due him in excess of one month's pay.

DISCHARGES.

In the beginning it was shown that efficiency would be promoted if our regulations resulted in permanence of service on the part of good men and facilitated the elimination of undesirables. The quicker men who are unfitted for naval life are removed the better it is for the service. We should not let our desire to establish a permanent body of men make us fail to differentiate between the good and the bad. A bad man's "room is better than his company." If we can get rid of a bad man early in his enlistment, before we have wasted a great amount of time on his training, we can replace him by a good recruit, but to retain him in service with the hope that he *may* turn over a new leaf is to risk both the contamination due to his example and the time required to train him. When men are lazy, worthless, dull, inapt and malicious they are generally so by nature, and such men, even after an entire cruise, are not of as much value as a good recruit, and the time that has been expended on their training, after their undesirability was shown, could have been used to train several good recruits—this, to say nothing of the pernicious example they have set in the meantime. There should be no temporizing with such men. Our interests would be subserved by discharging them in the beginning. If this is true, who are the most competent to decide as to the men's incompetence? Manifestly, the officers with whom they are serving. Not only is this logically true, but discipline would be strengthened if the officers who are directly responsible for this discipline were given the necessary authority to make it effective. When officers have not the authority to summarily punish an offense, however unruly a man may have been, he is always left the hope that through influence, through error, or through the leniency of those not fully acquainted with his real worthlessness, his penalty may be mitigated—a hope which, however poorly founded, has a pernicious effect on discipline. Is not the whole subject of thus safeguarding the discharge of men, sometimes even to the point of giving them another trial after they have been adjudged by a court of officers to be unfit or un-

desirable for the service, radically wrong? Is it not highly probable that an average recruit would be more efficient than such a man? Would it not subserve efficiency if the officers present could decide on a man's fitness for the service, at least during his first enlistment, and were authority vested in the commander-in-chief of a fleet or squadron to authorize his discharge, after having assured himself that the further retention of the man would be undesirable?

Is it not pernicious for enlisted men to feel that however lazy or inefficient they may be, their bed, board, and pay are safe; that we want men too much to afford to discharge any of them? Is it not pernicious for them to feel in a general way that they cannot be discharged unless they seriously commit themselves? Are such men not of far greater damage than a vacancy? Do we differentiate sufficiently between valuable units and harmful ones? Is it not true that most officers are inclined to leniency, and do we not allow the possibility of a personal injustice to the man to outweigh a consideration of what the best interests of the service require? When discharges must be authorized by an officer on duty at the Navy Department who can have no especial personal interest in individual men, but to whom the man must in most cases be but a name, is it not likely that a failure on the part of such officer personally to appreciate the worthlessness of the man will render him more lenient than if he had been the commander-in-chief of the squadron in which this man was serving? And if the man is so worthless as to cause the commander-in-chief to discharge him, is he not so worthless as to render his retention in the service undesirable? Moreover, though in theory it seems well that all discharges be ordered by a supreme authority, what is the result in practice? Do not the very necessities of the case prevent any person in high authority from deciding the merits of *each* case; must they not in almost all cases be decided by a junior, subject to the general directions and rulings of such superior? Could not these general rulings be transmitted as easily to a commander-in-chief as to said juniors?

We all know of many instances where worthless characters are dragged along for an entire cruise, receiving food and pay, doing little work, causing much annoyance and spending (probably voluntarily) much time in the brig, because it is practically impossible to get them discharged, except for very serious offenses. These

men may commit no overt act; or having been found guilty, recommended for discharge and pardoned, they may, while avoiding a repetition of an overt act, render reluctant obedience, and a minimum of efficient service. In either case, such men are a detriment to the navy. The fact that a man commits no overt act does not render him valuable, nor does it in itself justify the expenditure of the time necessary to train him; moreover, the knowledge of the "red tape" involved in discharge, tends to increase the worthlessness of such men.

If the immediate commander-in-chief or squadron commander of such men had full authority to discharge them, and if they had seen examples of men summarily discharged for no other reason than their worthlessness, would it not tend to remove an exalted idea of their value to the service, and either afford means of inciting their best efforts or of relieving the navy of their presence? Would they not soon begin to feel that the service was a business, a vocation in which persistently inefficient men would not be tolerated? Our present regulations offer various rewards to incite men's best efforts and to encourage continuous service, but some men, being naturally lazy and without ambition, are not reached by the stimulating effects of these rewards. Such men are of no help to the navy, but drag along and permit other men to do their quota of work. Is it not logical to get rid of them summarily, and in a manner that will have the best effect upon others?

I have observed at least one example of the beneficial effect of vesting the power of discharge in the commander-in-chief. On the Asiatic Station that officer could formerly authorize the discharge of Chinese messmen. For a while, about 1901, this authority was withdrawn, and the effect was soon noticeable, and after a few months the messmen became really troublesome; realizing that they could not be spared for confinement in the brig or for extra duty, they deteriorated, became lazy and inattentive, and, in some instances, impertinent. This authority was restored to the commander-in-chief after about a year, with the most noticeably beneficial result, though it was not accompanied by wholesale discharges. It simply became known that the authority existed, and that alone was sufficient to produce the effect.

For a commander-in-chief to have the power of discharge is simply in line with a similar custom in commercial life. Experienced men are probably not more important in the navy than

in other large organizations, but so far as I know, in all business enterprises the recommendation of any man in even small authority is sufficient to insure the discharge of any man directly under his orders. This gives to the men who are responsible an actual and ever-present hold over the men under them, with the corresponding increase in the efficiency of their respective departments.

SUMMARY.

It will be observed that though I began by discussing means for increasing the permanence of the enlisted personnel, I have suggested many features which facilitate the removal of men from the service. This is not illogical. Believing that the present pay is sufficient for our purpose, that men do not seriously object to necessary work, and that such work, if performed by a body of contented men, would result in naval efficiency, I have endeavored to seek the principal causes of discontent. I have tried to be fair and logical, my principal assumption being that enlisted men were impelled by the same motives that govern other human beings. I have endeavored to show that in any attempt to insure permanence of our personnel, it is quite as important to consider the mental attitude of the men as their physical requirements; that discontent can be created as easily by an assumed grievance as by a well-founded one; that the honestly assumed (and unexplained) grievance is just as harmful to contentment (and discipline) as the well-founded one; and that many of the causes of discontent are not necessarily incident to our entire efficiency. I believe that if the advantages offered by naval life were utilized, and unnecessary annoyances removed, we would have a body of men whose ambition would be to retain their positions permanently, as is the case with our officers, or as is the case in business life, rather than a body of men who are impatiently awaiting the expiration of their enlistment.

I believe that our present regulations are illogical in their attempt to *force* men to stay in the service, in their failure to take into account the influence of contentment upon efficiency and continuity of service, in their failure to facilitate the early discharge of men who are probably undesirable, and in their failure to so utilize the conditions which exist that men will desire to re-enlist instead of seeking outside employment. I think that the very

difference in attitude of the average enlisted man toward his term of enlistment, as compared with that of the average workman toward his vocation, must be corrected before we can expect a large percentage of men to make the navy their life work; and the fact that the average officer is satisfied to do this would seem to indicate that this could be accomplished without jeopardizing efficiency.

Among the points suggested, the following are mere matters of regulation and could be adopted without legislation.

1. Arrange cruises, in so far as possible, with special reference to suitable liberty ports, keeping the men informed of the probable movements as far ahead as practicable.

2. Recognize the military importance of furthering the contentment of the men by the employment of every proper means which does not interfere with efficiency.

3. Establish uniform and more liberal regulations concerning recreation on shore, and so far as possible avoid using deprivation of "liberty" as a punishment.

4. Establish throughout the service a more uniform official supervision over the regulation of messing.

5. Adopt a uniform policy of granting every application for discharge by purchase.

6. Adopt regulations facilitating the discharge of undesirable men, including a consistent policy of approving such recommendations from court-martial.

7. Prescribe for unauthorized absence over ten days a punishment as severe as that for desertion.

8. Change money regulations so that on any pay-day men can draw all they have on the books in excess of one month's pay.

The following changes would require legislation, but owing to their importance I do not believe difficulty would be experienced in getting it.

1. Substitute for deprivation of "liberty" as a *regular form of punishment,* a uniform, graduated scale of fines.

2. Amend retirement laws, as indicated, in order to combine incentives to continuous service with the establishment of an efficient reserve personnel.

3. Amend desertion laws so that the offense is complete after ten days' absence.

4. Amend deposit laws so that men can draw deposit money when they wish.

It is regrettable that the most important of these recommendations, the adoption of fines as a regular punishment, requires legislation. Some such *regular form* of punishment is necessary. Restriction of "liberty" is undoubtedly detrimental, extra duty is undesirable and impracticable as an habitual form of punishment, but fines are prompt, summary, final, and complete. They do not require the performance of duty by another person to see the punishment administered. They are therefore ideal, and their adoption would permit us to place service in the navy on much the same footing as service in any other vocation.

In conclusion, let us not forget that efficiency lies in our ability to maintain and handle the weapons under our charge; this means not only guns, but fleets, squadrons, ships, boats, as well as all weapons of offense or modes of defense with which we are provided. To attain this ability we require a body of well-trained men who are contented with their lot, and such a body of men can be acquired only by weeding out the bad as soon as possible, retaining the good permanently, concentrating attention on practical drills, and granting every privilege to the men not inconsistent with efficiency.

ROBERT SMITH, SECRETARY OF THE NAVY, 1801-1809.

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NAVAL ADMINISTRATION UNDER SECRETARIES OF THE NAVY SMITH, HAMILTON, AND JONES, 1801-1814.

By CHARLES OSCAR PAULLIN.

ROBERT SMITH, 1801-1809.

The administration of Thomas Jefferson, which came into power on March 4, 1801, differed definitely on naval questions from that of John Adams. The one wished to reduce the naval expenditures to the lowest terms; the other to appropriate most generously for officers, seamen, ships, docks, and navy-yards. The one favored a defensive navy; the other, an offensive navy. The one would build, if vessels must be built, sloops of war, gunboats, and barges, for the defence of the coasts and harbors; the other would add to the existing fleet of ships of the line and stout frigates, equal or superior to the best seagoing vessels of the European navies. In 1799 Jefferson had written to Elbridge Gerry that he was "for such a naval force only as may protect our coasts and harbors from such depredations as we have experienced." But he was not "for a navy, which, by its own expenses and the eternal wars in which it will implicate us, will grind us with public burthens, and sink us under them." In 1800 he declared that the country was running "navy mad."[1]

Jefferson's secretary of the treasury, Albert Gallatin, who in Congress in past years had vigorously opposed every measure for the increase or encouragement of the navy, now outdid his chief in proposals for retrenchment in naval expenditures. In 1802 he recommended that the cost of the navy for that year be reduced to $600,000. He considered one frigate and two or three small vessels "amply sufficient."[2] All the members of the Re-

[1] Ford, Jefferson, VII, 328, 406.
[2] Adams, History of the United States, II, 136.

publican party were not as strongly opposed to naval expenditures as Jefferson and Gallatin. On the other hand, the opposition of a few members went even farther. In 1802 Michael Leib, a member of Congress from Pennsylvania, moved in the House for a committee to consider the question of abolishing the navy.[3] In 1805 John Randolph said that he should not "be surprised to see the Navy Department abolished, or, in more appropriate phrase, swept by the board, at the next session of Congress."[4]

Randolph's wish may have been father to his expectation, for it is well known that he bore a lively antipathy to Jefferson's secretary of the navy, not a man of national note when chosen to the headship of the department. That Jefferson's chief naval adviser was of importance on account of his kin rather than on account of his weight in the public counsels, was not the fault of the President, for he made numerous attempts to obtain a national character to manage the navy. As early as December, 1800, before he knew certainly that he and not Aaron Burr was to be president, he offered the naval portfolio to Robert R. Livingston, of New York. Jefferson had the notion, which was common during the early history of the department, that a secretary of the navy should have some knowledge of maritime, naval, and commercial affairs. He keenly felt his need of a secretary of this sort, for he confessed that he knew less of the Navy Department than of any other branch of the government. Few Republicans, however, who had been bred to the sea or to commerce, possessed at the same time all the political and intellectual qualifications that were considered essential to a member of the cabinet. Livingston fell short in his knowledge of seafaring pursuits. When urging him to accept the secretaryship, Jefferson wrote to him as follows: "Tho' you are not nautical by profession, yet your residence and your mechanical science qualify you as well as gentlemen can possibly be, and sufficiently to enable you to choose under-agents perfectly qualified, and to superintend their conduct."[5] Livingston refused the tender.

In February, 1801, Jefferson offered the position to General Samuel Smith, a Baltimore merchant, and one of the most influential men in the Republican party. When Smith declined to

[3] Adams, History of the United States, I, 296-99.
[4] Adams, Randolph, 160-61.
[5] Ford, Jefferson, VII, 465.

abandon his business for the service of the government, the President decided on John Langdon, of New Hampshire, a Republican of national fame. On Langdon's refusal, he again turned to Smith, but without success. William Jones, a Republican member of Congress from Philadelphia, was now given an opportunity to decline the secretaryship. Meanwhile, Adams's secretary of the navy, Benjamin Stoddert, who in February had tendered his resignation to take effect in March, became tired of waiting. A temporary arrangement was therefore effected. Samuel Dearborn was made acting secretary of the navy; and Samuel Smith agreed to perform, nominally under Dearborn, the actual duties of the office.[6] The Republicans took possession of the Navy Department on April 1, 1801.

In May Jefferson wrote jestingly to Gouverneur Morris that he believed that he would have to advertise for a secretary of the navy. In June he once more offered the position to John Langdon, and for a time it was thought in Washington that Langdon would accept. In the same month General Smith returned to Baltimore and left the department in charge of Dearborn and Abishai Thomas, the chief clerk of the department.[7] On Langdon's second refusal Jefferson became discouraged in his search for national characters, and accepted Robert Smith, the brother of General Samuel Smith. It has been said that Robert's chief recommendations were the advice and aid which his brother Samuel was expected to give him. In its political aspect the appointment was a good one, for the family of the Smiths was well connected and influential in Maryland and Virginia. Robert Smith was a "Baltimore gentleman, easy and cordial, glad to oblige and fond of power and show, popular in the navy, yielding in the Cabinet, but as little fitted as Jefferson himself for the task of administering with severe economy an unpopular service."[8] After graduating from Princeton, Smith had practised law, and had served several terms in the Maryland legislature. In 1789 he was one of the presidential electors. He became the last survivor of the first electoral college, dying in 1842. For a time he

[6] Ford, Jefferson, VII, 484; VIII, 13-14, 28; Adams, History of the United States, I, 219-20.

[7] Ford, Jefferson, VIII, 49; General Letters, Navy Department Archives, IV, 409-10.

[8] Adams, History of the United States, I, 222.

was secretary of state under Madison. While Smith lacked the driving power of the statesman, he possessed in considerable measure the lubricating qualities of the politician, which by reducing the friction may greatly accelerate the speed of the administrative machine.

On July 15, 1801, Smith received a temporary commission, as the Senate was not then in session. He was confirmed by the Senate and recommissioned on January 26, 1802. On July 27, 1801, he relieved Dearborn and Thomas, and took charge of the department. He served continuously as secretary of the navy until March 7, 1809. Only two other naval secretaries, Gideon Welles, 1861-1869, and George M. Robeson, 1869-1877, have had longer terms of office. During Jefferson's second administration the official status of Robert Smith was an anomalous one. In January, 1805, Smith asked to be transferred from the Navy Department to the Department of Justice. Jefferson consented, and selected Jacob Crowninshield, a member of Congress from Massachusetts, to take the place of Smith in the Navy Department. Crowninshield declined the offer, as his wife did not wish to leave her kin and friends in Massachusetts and live in Washington. Nevertheless, on March 2, the President sent the nomination of Crowninshield to the Senate, along with that of Robert Smith, "now Secretary of the Navy to be Attorney-General of the United States"; and on the same day the two nominations were confirmed. Crowninshield still persisted in declining the secretaryship, and Smith continued to fill it throughout Jefferson's second term. According to the records of the State Department, Crowninshield during this period was secretary of the navy, although he died on April 15, 1808. From March 3, 1805, until March 7, 1809, Smith acted by no known authority except the verbal request or permission of the President.[9]

On July 31, 1801, two days after entering upon the duties of his office, Smith dismissed Thomas French, one of the clerks of the secretary's office, and appointed Thomas T. Anderson to the place made vacant. This appointment bears the ear-marks of a personal or political one, and seems to be the first application of the spoils system to the Navy Department proper—several Federalist navy agents had been removed before this. The two letters of Smith,

[9] Adams, History of the United States, III, 10-12.

one dismissing French, and the other appointing Anderson, are interesting; both were written on the same day. In one letter Smith denies the responsibility that he assumes in the other. To French he wrote: "An arrangement having been made and a Gentleman appointed to succeed you as a Clerk in the Office of the Secretary of the Navy, previous to my taking upon myself the functions of that office, it remains for me only to notify you of the Circumstance, and to assure you that since my arrival at this place I have observed with Satisfaction your prompt and cheerful Attention to your official Duties." The letter to Anderson read as follows: "Confiding in your Capacity and Integrity from the very respectable Manner in which you have been recommended to me, I have appointed you a Clerk in the Navy Office. You will therefore be pleased to come to this place as early as conveniently may be. Your Services are immediately necessary."[10]

A more important change in the force of the secretary's office was made on April 1, 1802, when Charles W. Goldsborough succeeded Abishai Thomas as chief clerk of the department. Goldsborough was promoted from the position of a subordinate clerk, which he had held since 1798. Some of his duties were prescribed in his letter of appointment: As chief clerk he was to have "under the superintending control of the Secretary, the custody and charge of all the Books, Papers, and Documents of every description belonging to the Department." He was to be responsible for the accuracy of the records of the department. "He must see that the Business of each day be brought up during that day, and that all the books and papers of the Office are arranged in the most regular order." He was to apportion the duties of the subordinate clerks, and to have charge of the appropriation for the contingent expenses of the secretary's office. In the future the secretary of the navy was to communicate only with the chief clerk, who was expected to "be duly prepared at all times when called upon."[11]

Goldsborough was one of the most important officials of the Navy Department during the first half-century of its existence. With the exception of a period of some two years during the War of 1812, he was connected with the department from 1798 to 1843.

[10] General Letters, Navy Dept. Arch., IV, 476-77.
[11] General Letters, Navy Dept. Arch., V, 273-74.

Although not a profound man, yet his knowledge of naval affairs, by virtue of his long service, was large and accurate. He was thus able to be of great assistance to the secretaries of the navy and to the board of navy commissioners, of which he was for a long time secretary. Students of the American navy are under many obligations to him for his Naval Chronicle, published in 1824, a narrative and documentary history of the early navy. He came of good Maryland stock. One of his sons was Rear-Admiral Louis M. Goldsborough, who rendered gallant service to the Union during the Civil War, and the other, Commodore John Rodgers Goldsborough, also a naval officer of this war.

For several years Smith employed but one other clerk in addition to Goldsborough and Anderson, but in 1806 a fourth clerk was added. The pay of the clerks were considerably higher under Smith than under Stoddert. The salary of the chief clerk was raised from $1200 to $1800 a year. In 1806 Congress limited the total compensation of the clerks of the secretary's office to $4900, and of the accountant's office to $8000. The office hours of the department began at nine o'clock in the morning, as at present, and closed at three in the afternoon, an hour and a half earlier than is now the rule. In 1803 Smith informed Congress that his clerks were frequently compelled to work over-time.[12]

The eccentric John Randolph, who was a most unfriendly critic of the Secretary of the Navy, has described an interview which he had with Smith and Goldsborough in 1807 at the Navy Office in Washington. There is plainly much caricature, as well as some truth, in Randolph's amusing picture. He had called to ask Smith for an explanation of certain items in the navy estimate for 1807: "The Secretary called up his chief clerk, who knew very little more of the business than his master. I propounded a question to the head of the department; he turned to the clerk like a boy who cannot say his lesson, and with imploring countenance beseeches aid; the clerk with much assurance gabbled out some commonplace jargon, which I would not take for sterling; an explanation was required, and both were dumb. This pantomime was repeated at every item, until, disgusted, and ashamed for the degraded situation of the principal, I took leave without pursuing

[12] U. S. Statutes at Large, II, 396; Congress Letters, Navy Dept. Arch., I, 134-35.

the subject, seeing that my subject [object] could not be attained. There was not one single question relating to the department that the Secretary could answer."[11]

On April 1, 1801, the day upon which the Republicans took charge of the Navy Department, the official axe fell promptly and the official lives of Higginson & Co., navy agents at Boston; and of James and Ebenezer Watson, navy agents at New York, came to an end. Exactly one month later, the Federalist navy agent at Portsmouth, New Hampshire, was removed; and Woodbury Langdon, a prominent Republican, was appointed to fill the vacancy. Within less than a year after Smith became secretary of the navy, all the chief naval agencies in the United States, except the one at Philadelphia, had been filled with Republicans. At first Jefferson was disposed to get along with fewer agencies, and several of the smaller ones necessitated by the war with France were discontinued. The destroying of offices, however, proved to be an unpopular and little appreciated work, and the Republicans soon found themselves creating new agencies. In 1804 a detachment of marines was ordered to New Orleans, as this city was now in possession of the Americans. A naval station under the command of a naval officer was soon located here, and a naval agent for New Orleans was appointed. In 1805 Captain Henry Carbery was sent to Cincinnati to act as a navy agent for the construction of gunboats on the Western Waters. In 1807 a navy agent for Cuba was appointed, and in 1808 one was chosen for Madeira. In February, 1809, a naval agency was created for Portland, Maine.

During the Tripolitan war of 1801-1807 it was necessary to provide the fleet in the Mediterranean with money, provisions, and naval stores. At first the American consul at Gibraltar and the firm of Degen and Purviance at Leghorn, who acted as navy agents, were thought sufficient for the work of attending to the needs of the fleet. But later naval agencies were established at Naples, Syracuse, Malta, and one for the two cities of Marseilles and Toulon. In 1804 William Eaton was appointed navy agent for the "Barbary Regencies." The firm of McKenzie and Glennie, of London, was the financial agent of the Navy Department, and supplied the commanders of the vessels and the agents in the Mediterranean with money. Supply ships were regularly sent

[11] Adams, Randolph, 211.

out from America to these agents. They were loaded with provisions of all sorts, and with candles, cordage, canvas, twine, and slops. The naval vessels that were sent to relieve the vessels in the Mediterranean of course always carried supplies for that station. The maintenance of a fleet at so great a distance from home was very expensive . Towards the end of the war Smith came to suspect that some of the supplies were diverted from their proper uses. He concluded that the division of the business of purveying among so many navy agents was not economical, and in 1807 he decided to concentrate their work at Port Mahon on the island of Minorca.[14]

During the first year of their administration, the Republicans were quite suspicious and critical of the transactions of their predecessors. When the Messrs. Watson, navy agents at New York, delayed the turning over of the public property to their successors, Samuel Smith, who was then in charge of the Navy Department, declared that they feared an investigation of their accounts. A contract for making hemp into cordage entered into by Messrs. Higginson, navy agents at Boston, appeared to Smith "to be a job." The purchase price of the navy-yard on Long Island seemed to him to be "extravagantly high." In July, 1801, Dearborn, while acting secretary of the navy, appointed a commission of seven men to reconsider the locating of the Philadelphia navy-yard. The commission, two of whose members were Captains Barry and Decatur, reported in favor of another site, but Smith decided against its purchase since the sale of the old yard would cause delays and embarrassments. He also decided against removing the New York yard from its site on Wallabout Bay, when the propriety of its location was questioned.[15]

Could Gallatin have had his way, the number of navy-yards would have been reduced. Jefferson also was inclined to favor a reduction. In his first annual message to Congress, after expressing a doubt whether the Federalists had been authorized to purchase and improve the several yards, he said: "I have in certain cases suspended or slackened these expenditures, that the legislature might determine whether so many yards are necessary as

[14] Barbary Powers Letters, Navy Dept. Arch., 1-44; General Letters, VIII, 299.

[15] General Letters, Navy Dept. Arch., IV, 321, 362, 400, 458, 516, 518, 524.

have been contemplated."[16] Congress and the Secretary of the Navy investigated and reported upon the subject, but in the end the Federalist purchases were allowed to stand and no reduction in the number of yards was made.

The Republicans were able to effect important economies in the management of the navy-yards by reducing the forces employed in them and by refusing to improve them after the manner contemplated by Adams and Stoddert, who before March 4, 1801, had begun the construction of wharves, shops, and sheds. In October, 1801, the duties of Marbury, the navy agent at Georgetown, District of Columbia, who had been dismissed in July, were vested in Captain Thomas Tingey of the navy, and he was made both navy agent for the district and superintendent of the Washington navy-yard. At Portsmouth, New York, Philadelphia, and Norfolk the naval constructors, clerks of the yard, and naval storekeepers were dismissed, and the yards were placed in the hands of the navy agents, each of whom was permitted to employ an assistant at a salary of $600 a year. Only at Boston were there left in service both a superintendent and a navy agent. Captain Samuel Nicholson, of the navy, who filled the former position, was probably considered too incapacitated by sickness and age to competently act as navy agent; and his gallant Revolutionary services plead too eloquently for him to admit of his removal from the superintendency. In 1804 the four civilian navy agents who were also superintendents received, in addition to their commissions on their purchases, $1200 a year, and were allowed an assistant and a porter.[17]

One of the last naval acts of the Federalist Congress, passed March 3, 1801, appropriated $500,000 to continue the construction of the six 74-gun ships and to complete the navy-yards, docks, and wharves; and $20,000 for the erection of marine barracks. These were the first specific appropriations for navy-yards, docks, and barracks, made by Congress.[18] A considerable part of the $500,000, the Republicans returned to the treasury unexpended, and but a very small part was devoted to the improvement of the yards. As early as June, 1801, Jefferson, however, ordered $4000 of the sum appropriated for barracks to be paid for "square No. 927 in Washington for the purpose of erecting thereon Barracks

[16] Ford, Jefferson, VIII, 122.
[17] General Letters, Navy Dept. Arch., V, 49, 53-58; VII, 19-23.
[18] U. S. Statutes at Large, II, 122-23.

for the Marine Corps." This lot, which constitutes a part of the present site of the Washington Marine Barracks, is situated near the navy-yard. It was purchased, and the construction of buildings was at once commenced.[19] The making of this expenditure accorded well with Jefferson's desire to promote the improvement of the capital city, and it therefore met his favor.

The navy-yard at Washington was the only one in which Jefferson manifested any particular interest. The seven ships, which the act of March 3, 1801, providing for a naval peace establishment, authorized to be laid up in ordinary, he directed to be brought to the Washington yard and to be laid up in the Eastern Branch, where they would require "but one set of plunderers to take care of them." He made this yard the chief depot of supplies and the repair shop of the navy. By February, 1806, the improvements in it made since its purchase had cost $177,000, a little more than had been spent on all the other yards. The Federalists in New England, and even in Virginia, raised the hue and cry over this diverting of the naval expenditures from home ports and the concentrating of them at a point so inconvenient to the sea as Washington. Jefferson defended his course on the ground that the navy and the naval establishment, which he thought would bear watching, were thus placed under the eye of the government. The inaccessibility and poverty of Washington and its lack of artisans, seamen, and ample naval resources, afforded an excellent opportunity for Randolph's stinging criticism. He declared that ship timbers and naval stores were repeatedly brought from Norfolk and were worked up by men obtained in Baltimore, Philadelphia, and other ports, in order that when worked up they might be returned to Norfolk. The mail coach, he said, carried to Washington for the navy-yard, workmen, live stock, "copper bolts, and such light articles."[20]

Jefferson's plan of erecting a "dry dock" at Washington for the preservation of ships formed a part of his policy of concentrating the navy at the capital. Among other characteristics of this singular and remarkable man was a taste for mechanical inventions, and especially those that promised to effect by a short cut some novel and striking economies or improvements. He

[19] General Letters, Navy Dept. Arch., IV, 343, 410, 425.

[20] State Papers, Naval Affairs, I, 150; Annals of Congress, XIV, 1009; XV, 324; XXI, 1971; Ford, Jefferson, VIII, 338.

doubtless derived the greatest satisfaction in conceiving and maturing the details and principles of his "dry dock." The primary purpose of his invention was not to facilitate the building or repairing of ships, although it was supposed that the dock would prove useful in these respects, but to preserve vessels during long periods of peace by preventing their decay from the action of water, sun, and weather. During peace Jefferson proposed to lay up nearly all the ships of the navy in the "dry dock," and discharge almost the whole force of officers and seamen. By November, 1802, he had worked out his plan with considerable detail. It provided for a lower basin, into which the vessels were to be floated by the tide. Adjoining this and twenty-four feet higher was an upper basin, 800 feet long, and 175 feet wide; and large enough to contain twelve frigates. These were to be raised from the lower to the upper basin by a lock or locks. On discharging the water in the upper basin, the frigates would be left high and dry. They were to be covered by a roof "like that of the *Halle du blé* at Paris, which, needing no Underworks to support it, will permit the Basin to be entirely open and free for the movements of the vessels." Jefferson thought that the water for the locks could be obtained either from the Potomac or from one of the three branches of that river in Washington, the Eastern Branch, Tiber Creek, or Rock Creek. If this dock proved to be successful, a second one was to be built.[21]

Jefferson obtained the services of Benjamin H. Latrobe, who later became one of the architects of the capitol, to make the preliminary surveys and to estimate the cost of the first "dry dock." Latrobe considered Jefferson's plan feasible, and recommended that the dock be constructed on the Eastern Branch. According to his estimate two such docks would cost nearly a million dollars. Beautiful and appropriate drawings, with estimates, which Latrobe prepared, were laid before Congress by the President. When these were considered in January, 1803, various objections were raised. Some members of Congress believed that the dock could not be economically constructed on the Eastern Branch; others thought that the ships would be strained and "wracked" by leaving them out of the water for a long time; and still others doubted whether they could be really preserved

[21] General Letters, Navy Dept. Arch., VI, 70-72.

in the dock. It was said that even under shelter, "septic vapors, with moisture, would exert their disorganizing powers" on the older vessels. It was asserted in favor of the dock that Sweden and Venice had constructed similar ones. Although the President considered his project one of great importance to the country and urged upon Congress its adoption, that body refused to follow him, and doubtless exhibited wisdom in its decision."

In deciding all questions of naval policy, the views of Jefferson and Gallatin prevailed. When Robert Smith in the summer of 1801 entered upon the duties of his office, he showed a disposition to make considerable improvements in the navy-yards, somewhat after the manner of the Federalists, but he soon learned in this as well as in all larger naval problems readily to yield to the opinions of the President and his brilliant secretary of the treasury. In the routine work of purchasing naval supplies and of making minor naval appointments, he was given a freer hand. The secretary of the navy at this time attended to many minor details such as are now never brought to his attention, engrossed as he is in the more general and more important duties of his position.

Each winter Smith laid in for his fleet a supply of salt beef and pork. In order to distribute the profits, these provisions were purchased in different states of the Union. In the winter of 1801-1802 Connecticut, New York, Maryland, and North Carolina furnished them. In later years the states on the Western Waters provided some of the meats for the navy. Smith gave his agents in this business the following specific directions in regard to packing the beef: "All the Legs, shins, necks, shoulders, clods, and Leg-rounds must be excluded—the rest of the Beef must be cut in pieces of 10-lb. each, so that 20 pieces will make a barrel—there must be a sufficient quantity of salt petre and it must be inspected and branded agreeably to law. The barrels must be made of white oak heart, and well bound."[22]

A letter of Smith to E. Williams, Hagerstown, Washington County, Maryland, dated May 31, 1806, illustrates still better the petty details upon which the first secretaries of the navy spent their time. It is hardly necessary to say that the "Spirit" to which Smith refers is West India rum.

[21] State Papers, Nav. Aff., I, 104-08; Annals of Congress, XII, 401-410; Ford, Jefferson, VIII, 188.

[22] General Letters, Navy Dept. Arch., V, 96.

"We require for the use of the Navy Yard here and for our Ships in commission, considerable Supplies of beans or peas and butter, and we have heretofore very often experienced considerable difficulties in procuring them. Our present annual consumption is about 1600 bushels of beans or peas, and about 12,500 lbs. of butter. Cannot Washington County supply us? If she can, inform me on what terms. There is, I have understood, a process of putting up butter, known in Washington County, to last for one year, without becoming ranced. If so, I would engage to receive in the month of Novr. or Decr. the whole quantity wanted for the ensuing year.

"The articles of Whiskey and Linseed oil I should suppose Washn. [County] might supply of good qualities and upon reasonable terms. The Sailors are by law allowed Spirit, but being persuaded that Whiskey is a more wholesome drink as well as a much more oeconomical one, I am anxious to introduce the use of it into our Navy generally; but this cannot be immediately effected. I have therefore made experiment to introduce it, and the result has satisfied me that in time the Sailors will become perfectly reconciled to it, and probably prefer it to Spirit. Our annual consumption of Spirit is about 45,000 Gallons. I would for the ensuing year engage 20,000 Gallons of Whiskey, but it must be pure rye whiskey of 3rd or 2nd proof, and one year old, if to be had. This Whiskey I would receive early in the ensuing year."[24]

One of Smith's duties related to the appointment and promotion of midshipmen. This position was exceedingly attractive to ambitious and adventurous youths, who longed for the thrill and romance of a seafaring life, but who knew nothing of its monotonies, its hardships, and its tragedies. Many of the applicants for a midshipman's berth were disappointed in their struggles to attain it. The usual brief formula of the secretary of the navy by which he deferred their hopes read as follows: "Your application for an appointment as midshipman in the navy has been received and filed on the roll of applicants. When vacancies occur in the corps of midshipmen your application shall be considered." Smith insisted that all applications should be accompanied with recommendations from men of worth and note who were personally acquainted with the young men. He once

[24] General Letters, Navy Dept. Arch., VIII, 172.

wrote to the Right Reverend Bishop Carroll of Baltimore, who had presented the claims of an applicant, that respectable connections, good education, and unexceptionable character, and especially the latter, were essential qualifications for the position. In a letter to DeWitt Clinton, who had written in behalf of a youth, and had enclosed a certificate stating that he had a "Good natural temper," Smith explained that this possession might recommend the applicant "in private life, but is not sufficient for a military one." A young man, he said, may be "extremely amiable and Respectable, yet unqualified for the Navy Service, which requires a strong Constitution of Body and mind, a high love of Character, and passion for Glory." In appointing midshipmen Smith tried to attend to the respective claims of the different states, and in 1808 he wrote that Virginia had her full proportion. In promoting midshipmen he had regard not so much to the seniority of the appointment, as to fitness, which he determined from the communications of the commanding officers.[35]

When the Republicans took charge of the navy, the most congenial duty of reducing it to the numbers fixed by the act of March 3, 1801, providing for a naval peace establishment, fell to them. In December, Smith reported the sale of sixteen vessels for $276,000, a sum scarcely sufficient for the purchase of one first-class frigate. In July, 1801, Jefferson ordered the privates of the marine corps to be reduced to 400 men. After the reduction, the number of commissioned officers of the corps was 31. In the navy, the rank of master commandant was discontinued. The captains were reduced from 28 to 15; the lieutenants, from 110 to 56; and the midshipmen, from 354 to 150. At times the whole number of officers and men did not greatly exceed 1000. In April, 1806, the number of able seamen, ordinary seamen, and boys was fixed by law at 925. In 1801 the Republicans expended $925,000 less than the Federalists had appropriated for that year. In 1802 the navy cost but $946,000. Never again were the expenditures of the United States navy to fall below the million-dollar mark. In 1800 the Federalists had spent on the navy $3,385,000.[36]

[35] General Letters, Navy Dept. Arch., VII, 136, 359; VIII, 72; IX, 156.

[36] General Letters, Navy Dept. Arch., IV, 449; State Papers, Nav. Aff., I, 80, 149; U. S. Statutes at Large, II, 390; Goldsborough, Naval Chronicle, 375-92.

It was the irony of fate that a President devoted to peace and to retrenchment in naval expenditures should have had to conduct one naval war and to face the probability that others might break out at any time. The war with Tripoli lasted from 1801 to 1806. Its picturesque events, notably Decatur's burning of the *Philadelphia* and Preble's spirited attacks against Tripoli, are familiar to all students of American naval history. During Jefferson's second administration a war with Spain was a possibility; and early in 1809 it was thought that a war with Great Britain could not longer be deferred. These circumstances forced the President after 1802 to gradually increase the naval expenditures. Early in his second administration he began to consider the advisability of building ships of the line, and Gallatin recommended the appropriating for this purpose of a million dollars a year for several years. To meet the needs of the Tripolitan war seven small vessels, mounting 14 or 16 guns, were built or purchased. In 1806, the rank of master commandant was restored; 9 officers of this rank were authorized, and the number of lieutenants was increased to 72. In December, 1807, the total number of officers and seamen in the navy was 2304. Early in 1809 when a war with Great Britain seemed imminent Congress authorized the President to increase the navy by the addition of 300 midshipmen and 3600 seamen and boys, and to add to the marine corps 784 officers and privates. The appropriations for the navy for 1809 were $2,917,000, but the actual expenditures were considerable less. Since the war clouds soon disappeared, only a small part of the contemplated naval increase was made. Randolph, who was not above juggling with figures to suit his own argument, declared that Jefferson's navy cost in 1808 for each seaman almost twice as much as Adams's. It is true that Jefferson's navy cost for each seaman much more than did that of Adams, but manifestly this is an unfair basis of comparison, for the fixed expenses of the naval establishment vary little with the enlisting or discharging of additional seamen.[m]

The largest naval increase made by Jefferson was at the same time the most useless. The "gunboat policy" was another of his naval inventions. As would the "dry docks," so would the gunboats save the country vast sums of money. These vessels cost

[m] Gallatin's Writings, I. 252; Annals of Congress, XXI, 1979, 1993; U. S. Statutes at Large, II. 390, 514, 544, 546; State Papers, Nav. Aff., I, 171.

little to build, and during periods of peace could be hauled up on shore and placed under shelter safe from the ravages of wind, wave, and weather. He found sanction for their use and proof of their value in the naval experiences of Algiers, England, and Russia. The opinions of Generals Horatio Gates and James Wilkinson and Commodores Samuel Barron and Thomas Tingey as to the efficacy of these vessels fortified his own.[28] In 1803 Congress authorized the construction of 15 gunboats; in 1805, 25; in 1806, 50; and in 1807, 188. In 1807 Smith estimated that the defence of the Atlantic coast and of New Orleans would require 257 gunboats.[29] The number of these vessels actually built was 176. The cost of their construction was $1,584,000; the cost of maintaining 24 gunboats in service at New Orleans for one years was $250,000. Gunboats were built at various ports on the Atlantic coast between Charleston, South Carolina, and Portland, Maine; on Lake Ontario; Lake Champlain; and the Western Waters; and at New Orleans. The first fifteen of them were authorized for the purposes of the Tripolitan war. All the later authorizations were for the protection of the harbors, coasts, and commerce of the United States.[30]

The construction of the first two gunboats was commenced in January, 1804. They were constructed "by way of Experiment and as models." One was built at the Washington navy-yard under the superintendence of Captain John Rodgers; and the other, at Hampton, Virginia, under the direction of Captain James Barron. In conducting their experiments in naval architecture, the two captains had the use of a plan of the gunboats of Messina and of a model of those of Naples.[31] To what extent the vessels that were later constructed followed the two experimental ones is not known. The gunboats varied in size; one of average dimensions was 60 feet long, 17 feet wide, and 6 feet deep. They were manned with twenty-five to forty-five men. They carried one or two large guns, 24-pounders or 36-pounders. They were not at all adapted to deep-sea navigation, nevertheless several of those first built actually made the trip across the Atlantic and took part in the Tripolitan war.

[28] State Papers, Nav. Aff., I, 163.
[29] U. S. Statutes at Large, II, 206, 330, 402, 451.
[30] State Papers, Nav. Aff., I, 194-200.
[31] Gunboat Letters, Navy Dept. Arch., 1-8.

Some of the gunboats were constructed of green timber and soon rotted. Others decayed through disuse and neglect. It took much money to keep them in repair. They could be built in time of war without much difficulty, and whole fleets of them have been so constructed in a few weeks; on the other hand, frigates and ships of the line could be built during a war only at the cost of much time, money, and effort. The service on board these vessels was very unpopular with both officers and seamen, nor did it fit them for duty at sea. It is true that many of Jefferson's gunboats were used in the War of 1812, and that other craft of this type were then built. But the actual protection that they afforded was small. All things considered, the construction of these vessels during 1804-1807 was a blunder and a misdirection of the national resources. As usual, Randolph was the most pungent critic of the administration. "Children must have toys and baubles," he said, "and we must indulge ourselves in an expense of many millions on this ridiculous plaything."[11] Jefferson was loth to learn that his versatile mind was not competent to master naval problems, whose solution belonged to men versed in the naval profession. It is fortunate for his fame that it does not depend upon his work as a naval administrator. In this capacity the only lustre that he acquired sprang from the successful prosecution of the war with Tripoli.

PAUL HAMILTON, 1809-1812, AND WILLIAM JONES, 1813-1814.

On March 4, 1809, James Madison, member of the Virginia line of Republican presidents, and heir to the policy and principles of Jefferson, entered upon his eight years of office. Three days later Paul Hamilton was nominated, confirmed, and commissioned as secretary of the navy. Why Madison should have chosen Hamilton for this position rather than a man of national renown is not known. Hamilton's public service had been confined largely to his own state. Before he was of age he took part in the Revolutionary war. From 1799 to 1806 he served his State first as comptroller and later as governor. This South Carolina gentleman and planter naturally brought to his task in the Navy Department no special knowledge of naval affairs. At this time such a deficiency was regarded as a considerable disqualification, although later it came to be not so considered.

[11] Annals of Congress, XXI, 1972.

The limited and provincial experiences of Hamilton made his outlook upon naval affairs somewhat narrow. Many of his standards, which had been established by a life of great simplicity and integrity, had, however, a wholesome influence upon the navy. The habits of thought, the customs, and the economies, which obtained upon a South Carolina plantation, were far from being amiss when applied to the administration of naval affairs. As secretary of the navy, Hamilton naturally insisted upon economy in naval expenditures, a scrupulous regard for the letter of the law, a conscientious attention to duty on the part of the higher naval officers, and correct habits for the midshipmen. This sober and dignified gentleman took a paternal interest in the young men of the navy. His praiseworthy attempts to form, or reform, their characters must have been often unsuccessful. Once he ordered Captain Tingey to tell several midshipmen, who frequented a public house in Washington and engaged in drinking spirits and playing billiards, "that the eye of the Department is upon them—that such practices will not be permitted—that a perseverance in them will make it my duty to dismiss them—and that I shall not fail to perform my duty on the occasion."[28]

The kindly heart, high sense of duty, and honesty of purpose, of Hamilton are well shown in the following communication, addressed to "Charles W. Goldsborough, First and confidential Clerk." The latter part of the letter is interesting for the light that it throws upon the current work of the department. The letter was dated August 12, 1809, about three months after Hamilton took charge of the Naval Office. The occasion of its writing appears from the context.

"In leaving only for a short time, as I contemplate, my office, I confess that I am not entirely easy, for certainly there are duties and trusts which can consistently with law be under the performance and guidance only of the Head of the Departments. In indulgences similar to that which I mean to take, I am informed have been usual, but they are not the less wrong—the prevalence of error, even universally, cannot constitute it as right.

"Under the influence of these Sentiments, in transferring duties, which properly I alone ought to perform, I am to be excused only by the necessity, which exists of my going to Carolina, for

[28] Navy-yard Letters, Navy Dept. Arch., I, 298.

PAUL HAMILTON, SECRETARY OF THE NAVY, 1809-1812.

the purpose of conducting my family to Washington, without whose presence I cannot longer consent to serve the United States; and while I think myself thus to be excused, my mind derives consolation only from the belief that in leaving my responsibility in your hands, I am safe.

"I have not long had the Satisfaction of a knowledge of you, but it has been sufficient to convince me that we are alike actuated by a desire to promote our Country's good, and the honor and dignity of the Department in which we act. This belief is strengthened by not only your faithful coöperations with me in official duties, but by the reputation which has been ascribed to you as a gentleman on whom every reliance may be placed. You know well my ideas as to the grand outlines of our duty, and as the first of these you are apprized that a wholesome oeconomy is to be observed as to disbursements, and that in no instance is an appropriation to be exceeded unless under Sanction of the President, who by Law is authorized to supply the deficiency of one fund from the Surplusage of another. . . . You know my Sentiments as to the equipment for Service of our Ships of War; refuse nothing which may conduce to their efficiency, and watch well the behaviour of our officers; attend also to the Navy Yard at Washington; 'tis a sink of all that needs correction, and if God spares me it shall be rectified; make advances according to your best judgment for a Steam Engine in the Navy Yard here, for a Shed in front of the Blockmaker's Shop, and a Coal oven in this yard; attend to the erection of a Magazine or Powder House here and at Gosport on Latrobe's plan; attend to the Subjects required by Congress at its annual Session, of which are reports of all the Contracts which we have made, and beyond which, but not the less to be attended to, is the requisiton of Mr. Randolph, as the Chairman of the Committee of Enquiry, I have only to add my firm persuasion that you will do your duty for your own sake and our Country's, and that thus you will gratify your mind, and effectually serve and oblige your friend—Paul Hamilton."[84]

In time of peace, with a president who looked at the naval affairs through Jefferson's spectacles, and with a Republican Congress in power that threatened to reduce the fleet to six small ships, Hamilton did not prove unequal to his post. But when the

[84] General Letters, Navy Dept. Arch., X, 71.

War of 1812 began, and there was demanded of the naval secretary decision, initiative, activity, expert knowledge, and skill in the handling of details, Hamilton fell short of the requirements of his position. Certain members of his own party were among his severest critics. In the summer of 1812 James Monroe, Madison's secretary of state, and Ex-president Jefferson agreed that, while the secretary of the navy possessed some merits, a change in the headship of the Navy Department was indispensable.[25] Nathaniel Macon, a Congressman from North Carolina, and a prominent Republican, considered Hamilton "about as fit for his place as the Indian Prophet would be for Emperor of Europe"; and William H. Crawford, a Senator from Georgia, declared that the secretary of the navy was incompetent, and complained that he diverted the naval officers from their proper duties in order to supply the heads of the departments with pine-apples and other tropical fruits.[26] One must, however, properly discount criticism of a member of the cabinet, which is made during the heat of a war, when sentiment and self-interest are often more influential than calm reason and unbiased judgment. Nor must it be forgotten that in the winter of 1812-1813 Madison's discredited administration sorely needed some scapegoats in order to appease the clamorous public and to shift the burden of blame. It still remains true that Hamilton did not measure up to the high stature of a successful war secretary.

Hamilton, who contemplated retiring from the cabinet at the end of Madison's first administration, or sooner if peace should be declared, was towards the close of 1812 urged to hasten his departure; and accordingly on December 31 he resigned.[27] On January 8, 1813, Madison nominated William Jones of Philadelphia to the vacant secretaryship. On the 12th Jones was confirmed by the Senate, and on the 25th he entered upon the duties of his office. It is recollected that Jones had been offered the same position by Jefferson in 1801, and had declined it. His appointment was probably as good as his party could supply. Niles' Register in announcing his choice referred to him as Captain William Jones, "an old and experienced seaman."[28] He had had

[25] S. M. Hamilton, Monroe, V, 260.
[26] Adams, History of the United States, VI, 290, 395.
[27] National Intelligencer, January 11, 1813.
[28] Niles' Register, III (1813), 320.

WILLIAM JONES, SECRETARY OF THE NAVY, 1813-1814.

considerable experience at sea, first during the American Revolution on board a privateer with Truxtun, and later in the merchant service. His career for many years as a merchant in Philadelphia was calculated to prepare him for his duties in the Navy Department. He was credited with having a considerable knowledge of gunboats and the arts of naval defence. He possessed information on the subject of shipbuilding, and regarded himself competent to criticise Robert Fulton's plans for a steam frigate. In 1814 he wrote to Fulton that the "principles and practice of Naval Architecture, having been a favourite study and pursuit, may apologize for these criticisms upon a subject on which you have bestowed so much thought."[*] Jones was a member of the American Philosophical Society. He was the author of a pamphlet on the Winter Navigation of the Delaware. Upon resigning from the Navy Department he served without distinction as the first president of the Second National Bank.

The organization of the Navy Department underwent no change under Secretaries Hamilton and Jones. The department still consisted of only two administrative divisions, the secretary's office and the accountant's office. The extra work necessitated by the war caused the force of clerks in the secretary's office to be increased to nine, and in the accountant's office to eleven. Hamilton continued Goldsborough as chief clerk; but Jones soon after entering upon his duties early in 1813 appointed Benjamin Homans, of Massachusetts, to this position. Goldsborough was not connected with the department for the next two years. Thomas Turner, who had been appointed accountant in 1800, continued in service under both secretaries.

The simplicity of the organization and work of the secretary's office is well shown by the duties of Hamilton's four clerks in 1810. The following information is derived from a statement of the secretary of the navy for the use of Congress. C. W. Goldsborough, who was paid a salary of $1900 a year, prepared, from minutes and under the immediate direction of the secretary of the navy, answers to letters received by the department; he made out the exhibits and estimates of the department for the use and information of Congress; and he performed various miscellaneous duties not within the regular routine of the office. Nathaniel

[*] General Letters, Navy Dept. Arch., XII, 158.

G. Maxwell, who was paid an annual salary of $1300, was the "office of detail." He kept the roll of officers, and prepared for signatures and recorded all the naval commissions and warrants of appointments; he also kept a record of all the letters of the department to the officers of the navy; and he endorsed and filed all the letters received, except those relating to the expenditure of money. These latter were in charge of Samuel P. Todd, who for an annual salary of $1300, served as a sort of "bureau of supplies and accounts." He prepared for signature and recorded all warrants for money, endorsed and filed all requisitions, and recorded the estimates and financial statements of the department. The fourth clerk, Conrad Schwartz, for the sum of $800 a year, did numerous odd jobs after copying the letters of the department into the "general letter books." He made copies, drafts, and charts; and translated foreign letters written in German or other European language into English. Hamilton said that the duties of these clerks were at times "extremely arduous and oppressive."[46]

Hamilton is to be credited with obtaining the passage of a most important law relating to the establishment of naval hospitals. In 1799 a law had been enacted authorizing the secretary of the navy to deduct twenty cents a month from the pay of each officer, seaman, and marine of the navy, and to pay the money thus received to the secretary of the treasury. In accordance with an act passed in 1798 a like deduction was made from the wages of each seaman in the merchant service. The whole fund thus realized was applicable to the relief of the sick and disabled officers, seamen, and marines of the navy, and the seamen of the merchant service. The money was expended under the direction of the secretary of the treasury. The navy and the merchant service received the benefits of the fund without discrimination. Their seamen were treated in the same hospitals, by the same doctors, and under the same regulations. The naval hospital service was not at this time separated from the marine hospital service.

In 1810 sick and disabled seamen were relieved at twenty-four of the chief seaports of the Atlantic and Gulf coasts. Only at Norfolk and Boston had marine hospitals been erected. In New York, Philadelphia, Savannah, and New Orleans provision was

[46] Congress Letters, Navy Dept. Arch., I, Dec. 17, 1810.

made for seamen at the city hospitals. At several ports they were boarded at private houses at the expense of the government. At Baltimore the seamen were supplied "under contract with doctor Tobias Watkins with every necessary thing, except cloathing and funeral expenses, at the rate of 55 cents a day for each seaman." At Alexandria, Virginia, they were in part cared for at the almshouse at the rate of $5 a week for each patient.[a]

With such inadequate facilities, no naval officer, and comparatively few seamen and marines of the navy, took advantage of their right to free medical service. In 1810 at the Marine Hospital at Boston the number of inmates during the year averaged twenty-four, one-fifth of whom were seamen of the navy; at Norfolk only one-ninth of the inmates were from the navy. Where the enlisted men did avail themselves of their rights, inconveniences and embarrassments arose from placing them, subject as they were to naval law and discipline, in institutions where no such law and discipline were enforced. It was difficult for the department to obtain reports from the officials and doctors of the hospitals, and when the seamen became convalescent they usually deserted. In order better to meet the needs of the navy, the department had permitted the use of several temporary naval hospitals. The one at New York was a rude structure situated in the navy-yard. It was proof against neither wind nor water, and was ill-adapted to even the needs of the well. "To give you some faint idea of what is called the hospital on this station," Captain Isaac Chauncey wrote in 1810, "imagine to yourself an old mill, situated upon the margin of a mill pond, where every high tide flows from twelve to fifteen inches upon the lower floor, and there deposits a quantity of mud and sediment, and which has no other covering to protect the sick from the inclemency of the season than a common clap-board outside, without lining or ceiling on the inside. If, sir, you can figure to yourself such a place, you will have some idea of the situation of the sick on this station."[b]

Such was the provision made for the relief of the sick and disabled of the American navy when Hamilton in February, 1810, recommended to Congress the separation of the naval and marine hospital services. On February 26, 1811, Congress passed an act

[a] Report of the Secretary of the Treasury, 12th Congress, 1st Session, Statement of Expenditures for Sick and Disabled Seamen.

[b] State Papers, Nav. Aff., I, 227-28, 233-34.

establishing naval hospitals. The money raised by deducting twenty cents from the monthly pay of the officers, seamen, and marines of the navy was now to be separated from the money similarly obtained from the seamen of the merchant service, and was to constitute the Naval Hospital Fund. This fund was to be controlled by a board of commissioners composed of the secretary of the navy, secretary of the treasury, and secretary of war. This board was authorized to purchase sites and erect buildings thereon. The secretary of the navy was directed to draft rules and regulations for the government of the naval hospitals.[1] These were in due time prepared by a commission of four naval surgeons, of which Dr. Edward Cutbush was the head. More than twenty years, however, elapsed before any naval hospitals were erected. In the meantime the temporary facilities within or near the navy-yards were extended.

Until early in 1812, when a war with Great Britain became imminent, Hamilton's administration of the navy was more or less uneventful. With the exception of the act establishing naval hospitals, no important naval legislation was enacted. In the spring of 1810 a significant bill was introduced into the House. In April of that year the House voted by a large majority to reduce the naval establishment—yeas 60, nays 31. Accordingly, a bill was reported by John Randolph to reduce the number of vessels in the navy to three frigates and three small craft; to discharge all the officers and seamen except such number as was necessary to man these six vessels; to discontinue the Portsmouth, Philadelphia, and Washington navy-yards, and to decrease the marine corps to two companies. The House spent much time in debating the provisions of this bill, but in the end it was unable to agree upon the reductions, which it had in the beginning voted to make; and the bill was dropped. The fact that a measure of this sort was seriously considered by the House on the eve of a war, and so soon after it had in 1809 voted to increase the navy considerably, convicts that body of marked incapacity of government.[2]

It was in the debate on the above measure that the management of the Washington navy-yard was attacked. Macon of North Carolina wished to continue the yard in order that Congress might

[1] U. S. Statutes at Large, II, 650-51.
[2] Annals of Congress, XXI, 1933.

have in plain sight an object lesson of the evils of a navy. "Sir," exclaimed John Randolph, "as long as a single chip remains in that navy-yard, you will never see anything like reform; as long as you have a chip of public property—one chip of live oak belonging to the United States—you will have a man riding in his carriage, with a long retinue and deputies and clerks to take care of it."[45] Randolph called the marine barracks in Washington the "Praetorian Camp." So unpopular was the Washington navy-yard, that even Hamilton declared that it was "a sink of all that needs correction, and if God spares me it shall be rectified." As a part of his work of reform, he considerably reduced the force of men employed there, which had at times been as large as 225 men. He established a naval school at this yard under the esteemed Doctor Andrew Hunter, a chaplain in the navy. He permitted the commandant to employ "twenty good Slaves belonging to the Neighbourhood."[46]

During the War of 1812, not only the six navy-yards which had been purchased by the Federalists, but also several naval stations, were used for the building and repairing of ships, the recruiting of seamen, and the storage of naval supplies. At New Orleans the Government had erected an armory, marine barracks, and some storehouses; and it maintained there a flotilla of gunboats and small armed craft. At Charleston, South Carolina, the department had been renting, for several years prior to the war, certain grounds, which it used for a naval station. In 1813 Secretary Jones was drawn into a considerable altercation over an alleged contract to buy this land. Its owner, Charles B. Cochran, maintained that Hamilton had in 1812 agreed to purchase it for a navy-yard. Jones refused to carry out the alleged contract on the ground that it was unauthorized by law, that the site was utterly unfit for a navy-yard, and that the price stated was at least four times the value of the land.[47] During the war the department had a naval station at Baltimore. From 1798 to 1816 when many naval vessels were built by contract, it is said that Baltimore constructed more ships for the navy than any other city in the Union. In 1810 Hamilton replied favorably to a memorial from the offi-

[45] Annals of Congress, XXI, 1953, 1970.

[46] General Letters, Navy Dept. Arch., X, 72, 301; Navy-yard Letters, I, 98.

[47] General Letters, Navy Dept. Arch., XI, 269.

cials of Annapolis in behalf of a navy-yard for that city, but he explained that nothing could be done at present since the navy was unpopular with Congress.[48]

The naval war on the Lakes during 1812-14 caused the Navy Department to obtain building yards and naval depots on Lakes Ontario, Erie, and Champlain. The most important of these were the grounds at or near Sacketts Harbor on Lake Ontario, consisting of three small lots. They were purchased for the government by Commodore Isaac Chauncey at a cost of $4425.[49] Sacketts Harbor was an exceedingly important naval station throughout the war. It was the rendezvous and headquarters of the American fleet on Lake Ontario. A naval hospital, naval school, and ropewalk were located there. Ten vessels, mounting from 16 to 74 guns, were built at Sacketts Harbor by Chauncey. Here, late in the war, the *New Orleans,* pierced for 100 guns, was placed upon the stocks, but she was never launched. Large quantities of naval supplies were sent to this station from New York city. The construction, manning, and equipping of the fleets on Lakes Ontario and Erie were quite the most brilliant work of its kind performed during the War of 1812. This work fell largely to Chauncey, one of the most efficient officers of the navy. His energy and activity is well shown by the following extract taken from a letter which he wrote to Hamilton from New York. It was dated September 26, 1812, twenty-three days after he received his appointment to the command of the fleet on the Lakes. He gives an account of the artisans, seamen, and naval stores, that were being sent from New York to Sacketts Harbor: "I have sent from this place 140 carpenters, about 700 sailors and marines (every man of which I am proud to say are volunteers), and more than 100 pieces of Cannon, the greater part of which are of a large calibre, with muskets, shot, carriages, etc., etc., and the carriages have nearly all been made and the shot cast since that time [September 3]; nay, I may say that nearly every article that has been sent forward has been made."[50]

The ship-yard for Lake Erie was early in the war located at Black Rock, on the Niagara river; but Chauncey soon removed it to Erie, on Lake Erie. Many ship carpenters, seamen, and naval

[48] General Letters, Navy Dept. Arch., X, 328-29.
[49] Congress Letters, Navy Dept. Arch., IV, 249.
[50] Captains' Letters, Navy Dept. Arch., 1812, III, 79.

supplies were sent from Philadelphia to Erie. Naval stores of all sorts were also purchased in Pittsburg. George Harrison, the navy agent at Philadelphia, who had general charge of the forwarding of men and supplies to Erie, employed a sub-agent at Pittsburg. Commodore Perry's two famous vessels, the *Niagara* and *Lawrence*, were built at the ship-yard at Erie. The building yard on Lake Champlain was situated at Vergennes, Vermont.

The regular navy agents employed at the chief Atlantic ports and at New Orleans were of course continued in service. At the beginning of the war additional agents became necessary, and they were appointed for several of the smaller Atlantic ports, and one for Niagara, New York. In 1812 an agent was chosen for Tennessee to purchase flour, hemp, and whiskey for the New Orleans naval station. The work of the navy agents, which consisted chiefly of the purchasing of naval supplies of all sorts, was greatly increased by the war.

It is recollected that in 1801 the navy-yards at Portsmouth, New York, Philadelphia, and Norfolk were placed under the superintendence of the navy agents at those ports, and that the Boston and Washington yards were permitted to remain in charge of naval officers. Gradually the civilian control of the four former yards was superseded by a naval one. The head of each navy-yard came to be called the "commandant," instead of the "superintendent"; and naval law and discipline was enforced in all the yards. In 1807 the New York yard received its first naval commandant in the person of Captain Isaac Chauncey. In 1810 Captain Samuel Barron took charge of the Norfolk yard, succeeding the Norfolk navy agent; and in 1813 the Portsmouth and Philadelphia yards were placed under naval captains. No civilian has served in the capacity of superintendent of a navy-yard since 1813. The New York yard greatly increased in importance during the war. The Washington yard lost its primacy among the establishments of the navy. After it was burned by the British in 1814, it never regained its former rank. The disaffection of New England towards the war and the Union rather decreased the value of the Boston and Portsmouth yards to the federal government. The relative importance of the several navy-yards is roughly indicated by the number of employees at work in them. In November, 1814, the number of officers and men employed at the Portsmouth yard was 18; at the Boston yard, 20; at the New York yard, 102; at

the Philadelphia yard, 13; at the Washington yard, 36; and at the Norfolk yard, 33.[51]

The imminence of a war with Great Britain naturally revived the consideration of the subject of dry docks. During peace, under the naval régime of Jefferson, dry docks could be dispensed with; but in time of war, when expedition was important and the fleet was greatly augmented, they were almost indispensable. In December, 1811, Hamilton informed Congress of the navy's deficiency. He wrote as if conveying a piece of news: "The United States do not own a dock. To repair our vessels we are compelled to heave them down—a process attended with great labor, considerable risk, and loss of time; and upon a ship thus hove down, the carpenters cannot work without much inconvenience. Hence the Department is subjected to much expense, which might be avoided by the construction of one or more suitable docks."[52]

Finally, on March 3, 1813, Congress appropriated $100,000 to establish a dock yard at some central and convenient place on the seaboard.[53] After making a general inquiry as to the best site, Secretary Jones decided in favor of the right bank of the Hudson above the Highlands. He said that "the motives to this decision were from considering the contemplated dock yard as the nucleus around which a great naval establishment may be formed, comprising wet and dry docks, forges, foundries, boring, rolling, saw, and block mills, blast and smelting furnaces, an armory, hydraulic engines, rope walks, manufactories of sail duck, and work shops of all kinds, which will require a copious head of water, readily commanded in this vicinity. Here also will be the main arsenal, and depot of timber and materials of all kinds, and the principal dock yard for constructing and repairing ships of war. Such an establishment in any of our seaports, accessible to ships of the line, would form so great a temptation to a powerful enemy as to render destruction certain, unless protected by forts and garrisons of the most formidable and expensive nature."[54] The blockade of the Atlantic coast, which the British had by this time effected, admonished Jones to locate his contemplated establishment at a safe distance from the coast. Occurring in the midst of a war,

[51] State Papers, Nav. Aff., I, 325-45.
[52] State Papers, Nav. aff., I, 249.
[53] U. S. Statutes at Large, II, 821.
[54] State Papers, Nav. Aff., I, 306.

nothing naturally came from this agitation in behalf of dry docks. It was no time to build them, to do the work that ought to have been done in time of peace. The failure of the Republicans to establish and construct dry docks during the ten years preceding the War of 1812 may be set down as another instance of their incapacity of government.

In the winter of 1811-1812 on the eve of the war with Great Britain, the Navy Department was unprepared in every essential means, instrument, and material of naval warfare. It had no dry docks. It had few ships. With the exception of the naval establishment at Washington, the navy-yards were in a state of neglect and decay. The navy had few conveniences for building, repairing, and laying up ships. In December, 1811, Secretary Hamilton informed Congress that the present stock of cannon ball, shot of every description, carronades, muskets, pistols, rifles, blunderbusses, and gunpowder was inconsiderable. The blame for this unfortunate state of affairs rests upon Presidents Jefferson and Madison and Congress, rather than upon the two Republican Secretaries of the Navy, Smith and Hamilton, who moderately favored the strengthening of the navy. Early in 1811 Hamilton had said that many measures of vast importance for the defence of the country might be effected, were the navy not unpopular with Congress. In November, 1811, he made his first preparations for war by buying a little saltpetre and sulphur. But for want of money, he could do little. He therefore appealed to Congress. On December 10 he asked for $400,000 to purchase arms and ammunition; and on January 14, 1812, Congress gave it to him.[55] Almost the only timber in the navy-yards was that which had been purchased by the department under Stoddert. On March 30 Congress therefore appropriated $200,000 annually for three years to buy timber for the repairing and building of ships. On the same day it voted $300,000 to repair and equip the frigates *Chesapeake, Constellation, and Adams.* On July 5 it appropriated $829,000 for purchasing and equipping vessels captured from the enemy, and for repairing vessels damaged by war. This Congress also voted to spend $1,000,000 on fortifying the maritime frontier.[56]

[55] Congress Letters, Navy Dept. Arch., II, 63; U. S. Statutes at Large, II, 675.

[56] U. S. Statutes at Large, II, 675, 692, 699, 776.

It is noteworthy that the war Congress, which was in session from November, 1811, until July, 1812, did not authorize the building of ships. It was not able to pass so radical a measure. Soon, however, the shock of actual war, the pressure of military necessity, the rebound of public opinion, and the patriotism aroused by glorious victories on the sea, effected a revolution in naval sentiment in and out of Congress. In the winter of 1812-13 conservative members continued to oppose energetic measures of naval defense, but they were not able to prevent the passage of the law of January 2, 1813, which appropriated $2,500,000 to build four ships of the line and six frigates.[87] From this time until the end of the war various other measures designed to increase and strengthen the navy were passed by Congress. The last act was that of November 15, 1814, which appropriated $600,000 for the construction or purchase of twenty small vessels of from 8 to 16 guns each.[88] The war caused the expenditures of the navy to increase as follows: from $1,970,000 in 1811 to $3,960,000 in 1812; to $6,450,000 in 1813; to $7,310,000 in 1814; to $8,660,000 in 1815. In 1816 the expenditures fell to $3,910,000.[89]

At the beginning of 1812 the navy consisted of eighteen vessels. Three of these were frigates, which had been built by the Federalists, and needed much repairing. The remaining fifteen were ready for sea. Seven of the fifteen, chiefly frigates, and mounting 254 guns, had belonged to the Federalist navy of 1798-1801; and eight, chiefly brigs, mounting 122 guns, had been built or purchased by Jefferson or Madison. The larger and the effective part of the navy of 1812 the Republicans inherited from the Federalists. In addition to the above fleet, there were 165 gunboats, which had been constructed by Jefferson. Of these, at the beginning of 1812, 63 were in commission, and 102 were in ordinary or undergoing repairs. The gunboats were stationed at the chief Atlantic ports from St. Mary's, Georgia, to Portland, Maine, and at New Orleans. Fifty-four of them were at New York, 26 at New Orleans, 20 at Philadelphia, and lesser numbers at other ports. Such was the naval force with which Madison began a war with the chief European naval power.[90]

[87] U. S. Statutes at Large, II, 789.
[88] U. S. Statutes at Large, III, 144.
[89] Senate Ex. Docs. 45th Long. 1st Sess., No. 3, 156.
[90] State Papers, Nav. Aff., I, 249, 250, 252.

When the war ended the navy comprised about 75 armed vessels of from 10 to 74 guns each, and about 240 gunboats, barges, and other small naval craft. The additions to the navy were made by construction, purchase, or capture. Of the vessels authorized under the act of January 2, 1813, three 74's and three 44's were built at the principal navy-yards, but they were not completed in time to be of use during the war. The 74-gun ship *Columbia*, when almost ready to be launched, was burned, at the Washington navy-yard, to prevent its being captured by the enemy. When the treaty of peace was signed, two 74's and two 44's were on the stocks at Sackett's Harbor. Some 60 vessels, largely insignificant craft, comprised the fleet on the Lakes. More than 200 gunboats, barges, and small craft were stationed at the chief Atlantic ports and at New Orleans.[1]

During the War of 1812 the repairing of vessels was an important activity of the Navy Department. Such work, in a few instances, was comparable to that of building a new vessel. One of the old frigates, which required a complete overhauling was the *Adams*. Apropos of the repairing of this ship is the following account of "A Launch," which was printed in the National Intelligencer of December 29, 1812, published at Washington: "On Thursday last, about half past 11 o'clock was launched from the Navy Yard at this City, the frigate *Adams*, which had been hauled up, divided in the middle, lengthened fifteen feet, and almost rebuilt. She proudly swam into her destined element at the appointed time, amid the acclamations of hundreds, and under a salute of artillery. After the launch many of the ladies and gentlemen assembled in a sail-loft, which had been cleaned for the occasion, and spent a pleasant hour. The *Adams* is to be commanded by capt. Morris." In the above account the Intelligencer, according to present standards, omitted a valuable piece of news, the presence on this interesting occasion of the President and members of Congress. This fact is proved by the following anecdote: When the frigate *Adams* glided off the stocks a Federalist member of Congress opposed to the administration, abruptly said to President Madison, with whom he was standing, "What a pity it is, sir, that the vessel of state won't glide as smoothly in her course as this vessel does." "It would, sir," Madison replied, "if the crew would do their duty as well."[2]

[1] State Papers, Nav. Aff., I, 305-09, 379-80.
[2] National Intelligencer, December 29, 1812; January 18, 1813.

Some historians of the War of 1812 have greatly overestimated the numbers of the personnel of the American navy. The total number of officers, seamen, and marines at the close of the war was about twice the number at its commencement. In December, 1811, the number of seamen and boys in the navy was 4010; and the number of marines, exclusive of commissioned officers, was 1823. The navy was probably as large in October, 1814, as at any time during the war. Secretary Jones then estimated the total force, exclusive of a few stationary marines, at 10,617. The Navy Lists for 1812 and 1815 show the increase in the numbers of officers caused by the war. The captains increased from 12 to 30; the masters commandant, from 9 to 17; the lieutenants, from 70 to 146; and the midshipmen, from 403 to 436. The number of commissioned officers in the marine corps in 1812 was 38; and in 1815, 59. In April, 1814, the number of marine was increased by 799. The number of seamen in the navy was throughout the war much below the needs of the service. In October, 1814, Secretary Jones estimated that 15,200 officers, seamen, and marines would be needed for the coming year.[65]

There was, however, no dearth of officers. The requests for offices in the navy were so many that, in order to preserve the time of the department for more important work, Jones established the rule that no applications for office should be answered. The applicants for the position of midshipman were especially numerous, and at the end of the war the files of the department showed that upwards of one thousand youths had been disappointed. Requests for employment were sometimes made by veterans of the Revolution. These always touched the kindly heart of Secretary Hamilton. For a veteran, Hamilton once wrote an order to Captain Tingey, commandant of the Washington navy-yard. The bearer, he informed Tingey, is "an old revolutionary officer for whom I wish to make some provision in the Navy Yard. He is too old to labor now, and he must not want. You will consider of some place in which his fidelity may be of use to the public, and report the same to me."[66]

A disproportionate share of the appointments of officers to the navy was made from Maryland, Virginia, and the District of

[65] State Papers, Nav. Aff., I, 255, 265; Private Letters, Navy Dept. Arch., 1813-1840, 196-202; U. S. Statutes at Large, 124-25.

[66] Navy-yard Letters, Navy Dept. Arch., I, 224.

Columbia. Of the 240 captains, masters commandant, lieutenants, and marine officers, whose names are printed in the Navy Register for 1816, 38 per cent were born in the above section. Of all the states of the Union, Maryland furnished the largest number, 46; and Virginia, the next largest number, 42.[65] The location of the Navy Department and the chief navy-yard in this section of the Union accounts in part for its large representation in the navy. Doubtless, too, Secretaries Stoddert and Smith and Presidents Jefferson and Madison were disposed to favor their own states in making appointment.

Jones cordially welcomed inventors of naval appliances and improvements, and gave them such financial encouragement as the limited resources of the department warranted. His knowledge of naval architecture made him an intelligent critic of some of these real or alleged inventions. He consulted his naval officers upon such subjects as came within their special knowledge, and at times had them report on the experiments and tests of the inventors. He ordered Captain Decatur to be present at the trial of an inflammable liquid, which was to be used in destroying the enemy's ships. He authorized a "multiplied repeating swivel, and a repeating musket and pistol" to be tried on board the vessels composing the flotilla on the Delaware. Jones approved of Uriah Brown's submarine boat. He gave Robert Fulton financial aid for three different inventions, a torpedo, a steam frigate, and a "bullet proof boat." Several of Fulton's torpedoes were manufactured at the Washington navy-yard. One of his steam frigates, *Fulton the First*, was built at New York; and another was begun at Baltimore. The department purchased one of his "bullet proof boats." These inventions, however, owing to their imperfections and the ending of the war when they were being brought into use, were of little value to the government.[66]

During the War of 1812 the Navy Department had constantly in view three main objects, the defending of the maritime frontier, the maintaining of the naval superiority on the Lakes, and the capturing of the enemy's small vessels of war and merchantmen at sea. Most American writers of the naval history of the War of 1812 have treated very briefly, or omitted altogether, the naval

[65] Roosevelt, Naval War of 1812, I, 55-56.

[66] General Letters, Navy Dept. Arch., XI, 265; XII, 158, 183, 258; Private Letters, 1813-1840, 39, 63; Miscellaneous Letters, 1814, VI, 72.

preparations and operations in defense of the Atlantic and Gulf coasts; and have confined their attention almost exclusively to the two latter objects enumerated above. The defense of the maritime frontier possesses few attractive features, and its study at most points is not conducive to national pride. Nevertheless, the fitting out and manning of vessels at the chief Atlantic ports and at New Orleans and the directing of their movements, for the purpose of defending the American seacoast, was a work of great importance and difficulty to the head of the Navy Department, and demanded much of his time and attention. At least one-half of the navy was employed in this way. Of the 10,617 men that constituted the entire naval force in October, 1814, 6512 were on the maritime frontier; 3260, on the Lakes; 450, at sea; and 405, in British prisons.[67]

The seamen on the maritime frontier were chiefly attached to the various flotillas, composed of gunboats, barges, and other small naval craft; some of them, however, were employed on board ships of war, and, owing to the close blockade which the British maintained during 1813-14, were much to their disgust detained in port and were compelled to assist in defending the coast. A flotilla was stationed at or near each of the following ports: New Orleans, St. Mary's in Georgia, Charleston, Wilmington, Norfolk, Baltimore, Philadelphia, New York, New London, Newport, Boston, and Portsmouth. Each flotilla was under the command of a naval officer, who sometimes reported to the commander of an adjacent naval station. The nucleui of these flotillas were collections of Jefferson's gunboats.

When the British blockaded the American coast and began to ravage it, a cry for naval protection was sent forth from Maine to Georgia. The same men who opposed naval expenditures during peace now blamed the government for not supplying naval ships that it did not have and could not get. Numerous requests for armed vessels were made of the secretary of the navy. He responded to as many of them as the limited resources of the department permitted. Early in 1812 Congress appropriated $1,000,000 for the defense of the maritime frontier. It also appropriated $750,000 for the construction of barges and floating batteries to be used for the same purpose.[68] Numerous small craft

[67] Private Letters, Navy Dept. Arch., 1813-1840, 196-202.
[68] U. S. Statutes at Large, III, 3, 104.

carrying a few heavy guns were added to the various flotillas. Each locality coöperated with the Federal government in the work of defense. This service on the seacoast was, however, unpopular with both officers and seamen, for it was not suited to their habits or comforts; nor was either glory or prizes to be obtained in it. To man the vessels was difficult, and often impossible. The log-book of a certain gunboat records the fact that after much difficulty two men only were enlisted—"from the jail, with a parenthetical memorandum to the effect that they were both very drunk."[a] The usefulness of the flotillas was greatly impaired owing to the want of seamen. These little fleets, however, were able to supplement the land defenses, and to check to some extent the ravages of small British ships on the coast. But they offered little resistance to strong fleets. They did not prevent the enemy from making frequent depredations. No better proof of the ineffectual character of their work is needed than that afforded by the raid of the British in August, 1814, when they destroyed Barney's flotilla and burned Washington.

The most uniformly successful work during the war of both the Navy Department and the navy was the obtaining and holding of the naval superiority on Lakes Ontario, Erie, and Champlain. The martial deeds of Commodores Perry and Macdonough have been amply celebrated. But the achievements of the Navy Department and of Commodore Chauncey in providing the instruments and sinews of war are equally noteworthy, although less dramatic. With much energy and expedition they constructed fleets from the trees standing in the forests, hastened forward artisans, armament, and naval stores of all sorts from the seaports, and enlisted seamen wherever they could be obtained. At times both the service on the maritime frontier and at sea yielded to that on the Lakes. In 1814 in order to man the fleets of Commodores Chauncey and Macdonough, heavy drafts of men were made on the flotilla service, and rendezvous for recruits were opened in various seaports. Ships which had been destined for the sea were laid up in ordinary, and their armaments and crews were sent to the Lakes. The Lake service, however, was not liked. Secretary Jones wrote that it was "one of peculiar privation, destitute of pecuniary stimulus, and unpopular both with the Officers and Men." While but 3250 sailors were employed

[a] Roosevelt, Naval War of 1812, 45.

on the Lakes during 1814, he estimated that 7000 would be needed in 1815. Many additional seamen were required to man the new ships. The contest on Lake Ontario, Jones said in October, 1814, had become a "warfare of Dockyards and Arsenals."[70]

The Muse of history, national pride, and popular tradition have vied with each other in perpetuating the fallacy that the American navy inflicted serious injury on the British navy in the War of 1812. During 1812-1815 the Americans captured 23 British naval vessels of from 10 to 38 guns each; and the British captured 17 American naval vessels of from 10 to 44 guns each—not including the ships burned at the Washington navy-yard. Of the 23 British ships captured by the Americans, four were taken by Perry on Lake Erie, four by Macdonough on Lake Champlain, and four were captured after the treaty of Ghent was signed. Of the eleven remaining vessels, the five principal ones were captured during the latter half of 1812.[71] In 1813 and 1814, owing to the British blockade of the American coast, the naval war on the ocean almost ceased; the little that existed was in favor of the British. No vessel captured from the enemy was so heavily armed as the *Serapis*, 44, the Revolutionary prize of John Paul Jones. In 1812 the Royal Navy consisted of 130 ships of the line, mounting from 60 to 120 guns, and 600 frigates and smaller vessels. The value of the twenty-three ships captured by the Americans was not equal to that of two of England's best ships of the line. Of course these figures do not depreciate the skill and courage of the American commanders, nor dim the glory and prestige that they won for the American navy. The striking success of the American ships in the engagements between the *Constitution* and *Guerriere*, the *Essex* and *Alert*, the *Wasp* and *Frolic*, the *United States* and *Macedonian*, and the *Constitution* and *Java* will ever make the latter half of 1812 a memorable time in our naval history. It is also true that the moral effect of the brilliant fighting of the American navy was greatly to the advantage of the government at Washington, and to the disadvantage of that at London.

The exact determination of the department early in 1812 in respect to sending the vessels to sea is still involved in obscurity. It has been asserted that the cabinet sometime during the first

[70] Private Letters, Navy Dept. Arch., 1813-1840, 196-202.
[71] Emmons, Navy of the United States, 6-11, 18-21, 56-59.

half of 1812, deeming it unwise to jeopardize our small ships in a contest with the gigantic British navy, decided that the American fleet should be laid up in ordinary for the period of the war; and that Captains Bainbridge and Stewart drew up a remonstrance, which led the secretary of the navy to abandon this policy of prudence and fear. Considerable doubt has now been cast on the accuracy of this story. It is certain that on June 22, 1812, Hamilton ordered the fleet to be divided into squadrons and to cruise off the Atlantic coast for the protection of American commerce. In September the fleet was arranged in three squadrons of three vessels each, and they were ordered to proceed to sea. After 1812 the ships usually cruised singly, since the close blockade, which the British maintained off the chief American ports, interfered with the sending out of squadrons.[72]

The movements of the secretary of the navy and the Navy Department during the raid of the British on Washington, in August, 1814, are, in the annals of the department, wholly unique and exceptional. It is appropriate that a brief account of them should be here given. They form a part of a most interesting melodrama, whose principal characters are the President of the United States and the dignified members of his cabinet. The destruction of the Washington navy-yard is one of the thrilling features. Jones's report of his own movements, which were most numerous, varied, and rapid, will be followed. By August 22 Commodore Joshua Barney, having burned his "American Flotilla" on the Patuxent in Maryland, had retreated with his seamen and marines towards Washington. He was closely followed by a small detachment of British troops under General Ross. On the night of the 22nd Barney and General Winder, who commanded the American troops, camped at Old Fields in Maryland, seven miles from Washington. Jones writes in respect to his own movements on the 22d as follows: "In the evening of that day I accompanied the President to General Winder's Camp at the Old Fields, and passed the night in Commodore Barney's tent—the Army of the Enemy at Upper Marlborough eight miles distant—on the morning of the 23rd reviewed the Seamen and Marines, whose appearance and preparation for battle promised

[72] Harris, Commodore Bainbridge, 135-36; Gallatin's Writings, II, 611-22; Officers' Letters, Ships of War, Navy Dept. Arch., X, 66; Navy-yard Letters, I, 329; John Rodgers Papers.

all that could be expected from cool intrepidity, and a high state of discipline." On the afternoon of the 23rd Jones and Madison returned to the capital. The army and the navy frightened by the advance of the British now made a sudden retreat and reached Washington not long after the arrival of the Secretary of the Navy and the President. The military and naval forces rested near the navy-yard and the adjacent bridge across the Eastern Branch of the Potomac.

On the 24th the battle of Bladensburg was fought, and the British entered the capital. Bladensburg is situated on the Eastern Branch, about five miles from Washington. Let us return again to Jones's narrative: "On the morning of the 24th I proceeded to General Winder's quarters at Doctor Hunter's house near the Eastern Branch Bridge, where the President and Secretaries of War, State, and Treasury soon after arrived. I found Commodore Barney employed by order of the General in planting his Battery on the hill near the head of the Bridge. He was charged to defend that pass and to destroy the Bridge on the appearance of the Enemy, for which purpose Scows and Boats with combustible materials were placed under the Bridge ready to explode. At this time the Enemy was apparently advancing on the road to the Bridge; but shortly after advice was received that he had turned off on the road towards Bladensburg." General Winder with his troops now hastily marched to Bladensburg in order, if possible, to head off the British, leaving Barney and his force of seamen and marines to guard the bridge. "It was soon observed that a very efficient part of the force had been left to destroy the Eastern Branch Bridge, which could as well be done by a half dozen men, as by five hundred. The subject was discussed by the President, Heads of Departments, and Commodore Barney, which resulted in the order for his immediate and rapid march to join the army near Bladensburg. Captain Creighton was left in charge of the Bridge to destroy it on the near approach of the Enemy." Jones now presented to the President and his cabinet the subject of the navy-yard; and it was agreed that, if the enemy should approach the city, the Secretary of the Navy should order all the buildings, naval stores, and ships in the yard, to be destroyed, rather than let them fall into the hands of the British.

At two o'clock in the afternoon Jones was to be again found at the Washington navy-yard. He ordered the commandant, Cap-

tain Tingey, to prepare trains of powder, and to touch them off on the approach of the enemy. The battle of Bladensburg resulted in the complete rout of the Americans, who, with the exception of Barney's seamen and marines, made an ill-conceived and half-hearted resistance. The British now advanced upon Washington. As they entered the city, Captain Tigney at half-past eight o'clock in the evening set fire to the navy-yard. The next day the British continued its destruction. The most valuable parts of the yard were destroyed. The whole loss was estimated at $418,000. The largest single item of loss was the 74-gun ship *Columbia*, valued at $106,000. Some days before the invasion the Secretary of the Navy had ordered the gunpowder, lighter stores, and smaller vessels to be removed to a point of safety northward of the city, but few materials were thus saved.

Soon after Jones retired from the navy-yard on the afternoon of the 24th, he heard that the enemy was moving towards Washington from Bladensburg; and a little later at the house of Charles Carroll he received a message from Madison requesting him to follow and join the party of the President, which had already crossed the Potomac at Georgetown. Jones and the Attorney-General followed the fortunes of their retreating chief. The party travelled until dark and spent the night on the Virginia side of the Potomac a few miles above the Lower Falls. The next day it reached a little Virginia tavern, situated in the midst of an apple orchard, sixteen miles from Washington, where it rested. On the evening of the 25th the British, having occupied the capital for twenty-four hours, left it. On the 28th the Secretary of the Navy returned to Washington; and his week of melodrama came to an end. The "old war office," which had housed the Navy Department since 1801, was among the public buildings destroyed by the British. Jones rented temporary quarters for the department.[n]

The movement of the Navy Department during these troublous times is best told in the words of Benjamin Homans, its chief clerk: "In obedience to instructions from the Secretary of the Navy to prepare for the removal and safety of the Public Documents and Archives of the Navy Department on Saturday, the 20th day of August, 1814, and anticipating a difficulty in pro-

[n] Congress Letters Navy Dept. Arch., II, 271-80, 294-98; Cutts, Dolly Madison, 99-118; Adams, History of the United States, VIII, 120-168.

curing Waggons, he sanctioned the transportation by Water in Boats up the Potomac River. On Sunday three of the Clerks were employed packing up in Boxes and Trunks, all the Books of Record, Papers, Library, Maps, Charts, Plans, Stationery, Trophies, various valuable Instruments, Paintings, Prints, etc., ready for removal on the next day. And in the evening of Sunday, the 21st August, two River Boats with their Crews were engaged for the purpose at the ordinary Wages.

"On Monday, the 22nd August, two of the City Carts were engaged, and all the Boxes and Articles in the Navy Department (heavy Desks and furniture excepted) were put on board the Boat at the nearest Wharf to the Offices, and at 4 P. M. proceeded up the River as far as Georgetown. In the forenoon of Monday, the 22nd, two large Waggons with drivers presented themselves at the Department for employ, and on account of the previous arrangements, to transport by Water, they were transferred to the Accountant of the Navy Department, who loaded them with the Effects of his Office.

"On Tuesday, the 23rd August, the Chief Clerk with one of the Clerks of the Department proceeded up the River Potomac, and passed through the Locks and Canal to a place of safety. There was no difficulty in procuring more boats, and men enough to navigate them up the River above the Falls."[74]

Secretary Jones found his duties arduous and confining; nor did his management of the department escape adverse criticism. By April, 1814, he had decided to retire from the cabinet, because of the indispensable attention that his private affairs required.[75] The position of secretary of the navy has always been vastly more attractive to the candidate seeking it, than to the incumbent performing its duties. Each of the first four secretaries, Stoddert, Smith, Hamilton, and Jones, longed for more congenial work. Jones would not wait until the war was ended. On September 11, 1814, he tendered his resignation to take effect on December 1. On the latter date he turned over the keys of the department to its chief clerk.

[74] Congress Letters, Navy Dept. Arch., II, 299-300.

[75] Ingersoll, History of the Second War between Great Britain and the United States, 2d ser., II, 326; Madison's Writings, ed. 1865, II, 581-82.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

A NEW METHOD IN NAUTICAL ASTRONOMY.

(SECOND PAPER.)

By H. B. GOODWIN.

In the number of the PROCEEDINGS for December, 1905 (Vol. XXXI, No. 4), there was included a paper which, under the title of "A New Method in Nautical Astronomy," gave a description of a new process for deducing hour angle of body, and, therefore, longitude of place, from the altitude of a star situated near the prime vertical by means of tables.

The paper in question was limited to a general account of the principles of the method, with a practical example of its application in the case of the star Antares for latitude 55° S. Now that the tables have been published[1] a slightly more detailed description of their construction, and of the objects which it is proposed to accomplish by their aid, may perhaps be acceptable to readers of this journal.

It may be well first to briefly recapitulate the principles on which the method is based.

Near the prime vertical a heavenly body moves in altitude with a velocity which, with certain limitations, may be regarded as uniform, and which, in a given latitude, is independent of declination, and is, therefore, the same for all bodies. If, therefore, we have given the hour angle and zenith distance of a particular body upon the prime vertical, and also the rate of change of altitude appropriate to the particular latitude, we may find the hour angle corresponding to a given zenith distance, or conversely the zenith distance corresponding to a given hour angle, by an

[1] The work is entitled "Position-Line Star Tables," by H. B. Goodwin, R. N., published by Mr. J. D. Potter, Admiralty Agent for Charts, 145 Minories, London E. Price, five shillings.

application of the principle of proportion. The work of finding hour angle or zenith distance near prime vertical, therefore, becomes similar in character to that of correcting an element taken from the Nautical Almanac.

The accuracy of the method may be relied upon, when only the first or principal correction is employed, within a limit of one minute of arc, or four seconds of time, up to thirty or forty minutes of hour angle on each side of prime vertical according to the latitude of place. When, however, a "Second Correction" given in the tables is taken into account this limit is extended, for all latitudes as high as 60°, to about 70 minutes on each side of prime vertical, and in low latitudes to a limit much larger still. Generally, the tables will be available for a period of upwards of two hours when the bearing of star is nearly East, and again for a similar period when it is nearly West, *i. e.*, for about four hours and a half in all for each star.

It should be pointed out here that near the equator, so soon as the declination of the body equals in value the latitude of place, the star will not pass the prime vertical at all. When declination of star exceeds latitude of place, however, the body will at some point of its diurnal path be in the position of maximum azimuth, the angle at the body, or "Angle of Position," being then a right angle. Here also, as upon the prime vertical, the altitude changes at a uniform rate, so that by tabulating hour angles and zenith distances for this position of maximum azimuth we may extend to low tropical latitudes the same principle of proportion which in higher latitudes is available near the prime vertical.

There are included altogether five tables, but only two of them, viz., Tables II and III, have direct reference to the new processes for stars near prime vertical. The five tables are as follows:

Table I.—This is subdivided into Tables I (A), I (B), I (C), and I (D), which give the sidereal times of transit over prime vertical, circle of maximum azimuth, and meridian. Since the sidereal time at which in a given latitude a particular star passes one of these circles is practically constant, the approximate sidereal time, which is easily obtained by adding ship mean time to right ascension of mean sun, seems to offer a convenient argument for a table of this nature, the object of which is to find what stars are conveniently situated for observation at a particular time.

Table II.—This table again is subdivided into three parts: Table II (A), Table II (B), and Table II (C). Table II (A) gives the hour angles and zenith distances on prime vertical for use in finding the first, or principal correction. The limit of latitude is 60°.

The following extract from the table for Aldebaran (Dec. 16° 19′ N.) will illustrate the method of arrangement:

Latitude.	Hour Angle.	Correction for change of Declination.	Zenith Distance.	Seconds of Time for change of one degree of Zenith Distance	Change of Zenith Distance per minute of Time.
		(*a*)		(*b*)	(*c*)
	h. m. s.	s.		s.	′
60°	5 21 5	6.8	71° 4′ 15″	480	7.50

(*a*) *Increased* declination *add*. *Decreased* declination *subtract*.
(*b*) For use in finding hour angle from zenith distance.
(*c*) For use in finding zenith distance from hour angle.

The correction for change of declination given in the third column, the nature of which was described in the earlier paper, is intended to compensate the effect of the difference between the actual value, and that for which the table was calculated, which in the case of Aldebaran was 16° 19′ N. The effect of "Annual Variation" in declination for a very considerable period is thereby provided for.

Table II (*B*).—This gives the "Second Correction," additive to "First Correction," in finding hour angle from zenith distance. The arrangement for latitude 60° is as follows:

SECOND CORRECTION.
(Additive to First Correction.)

	Approximate Distance in Hour Angle from Prime Vertical.														
Latitude	m 20	m 25	m 30	m 35	m 40	m 45	m 50	m 55	m 60	m 65	m 70	m 75	m 80	m 85	m 90
	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s
60°	1.2	2.4	4.0	6.2	9.2	13.0	17.8	24.0	31.0	39.2	48.9	60.2	73.0	87.8	104.0

Table II (*C*).—The "Second Correction," subtractive from "First Correction," for use in finding zenith distance from hour angle.

SECOND CORRECTION.
(Subtractive from First Correction.)

	Approximate Distance in Hour Angle from Prime Vertical.														
Latitude	m 20	m 25	m 30	m 35	m 40	m 45	m 50	m 55	m 60	m 65	m 70	m 75	m 80	m 85	m 90
	″	″	′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
60°	9	17	29	46	1 9	1 38	2 14	2 59	3 51	4 54	6 7	7 32	9 8	10 58	13 0

Table III.—This table is similar in arrangement to Table II (A) and gives hour angles and zenith distances for the sev-

eral stars when at maximum azimuth. No subdivision of this table is required, because Tables II (B), II (C) furnish the values of "Second Correction," if declination of star, instead of latitude of place, is taken as an "argument."

Table IV is not entirely new, nor is it immediately concerned with our present purpose. It gives within the compass of a few pages of tabular matter the means of reducing an altitude observed on a small bearing to the meridian, employing the arguments of azimuth and approximate latitude, and was first published in 1903 through Messrs. Griffin of Portsmouth.[2] It is included here so that the navigator may have within the limits of a single volume a concise method of reducing a second star to the meridian, and thus obtaining a complete "fix" in latitude as well as longitude.

Table V.—This is divided into two parts: Table V (A), and Table V (B). Its object is a simple one, viz., to assist in readily expressing a portion of arc given in minutes and seconds as the decimal of a degree, or a given portion of time expressed in seconds as the decimal of a minute. Thus, suppose that we have to deal with a difference of zenith distance of 7° 17′ 30″. Reference to the table shows that 17′ 30″ is .292 of a degree, and we avoid a troublesome arithmetical process, and write down at once 7°.292 as the value required.

So, again, if we have to deal with a difference of hour angle such as $41^m\ 27^s$, from Table V (B) we find that 27 seconds is .45 of a minute, and we write down $41^m.45$ as the value. Unnecessary labor is thereby avoided, and risk of error greatly diminished.

To illustrate practically the use of the tables let us suppose that on the present date, which happens to be August 6, 1906, it is required to find what star or stars are available for observation near prime vertical in evening twilight, say one hour after sunset, first in latitude 50° N., then in latitude 10° N.

FOR LATITUDE 50° N.

From the almanac we have mean time of sunset approximately $7^h\ 31^m$, R. A. mean sun $15^h\ 1^m$. The sum of these quantities, or

[2] A New Table for Solving the Ex-Meridian Problem on Kinematic Principles, by H. B. Goodwin, R. N. Griffin and Co., 2 The Hard, Portsmouth. Price, one shilling.

$22^h\ 32^m$, is, therefore, sidereal time of sunset. One hour later sidereal time is $23^h\ 32^m$.

For the two latitudes we have from Table I (A):

APPROXIMATE SIDEREAL TIME AT WHICH STARS PASS THE PRIME VERTICAL IN NORTH LATITUDE.

	Lat. 50°				Lat. 10°			
	East		West		East		West	
α Andromedæ,	19^h	52^m	4^h	15^m				
α Arietis,	21	25	6	38				
Aldebaran,	23	27	9	34				
Betelguese,	0	15	11	25	2^h	59^m	8^h	41^m
Pollux,	3	27	11	52				
Regulus,	4	46	15	21				
β Leonis,	6	37	16	52				
Arcturus,	9	21	19	1				
α Coronæ,	11	12	19	49				
Altair,	14	15	1	17	17	43	21	49
Markab,	17	51	4	9				

Thus we see that either of the fine stars Aldebaran or Betelguese are immediately available to the eastward, while Altair will be crossing the prime vertical to the westward in less than two hours, and will, therefore, come within our limit of 70 minutes very shortly.

Let us suppose that Aldebaran's zenith distance was observed about this time or a little later, and found to be 62° 4′ 24″. Required the hour angle. Declination of star 16° 22′ N.

From Table II (A) we have:

ALDEBARAN DECLINATION 16° 19′ N.

Latitude.	Hour Angle.	Correction for change of 1′ in Declination.	Zenith Distance.	Seconds of Time for change of one degree of Zenith Distance.	Change of Zenith Distance per minute of Time.
	h m s	s		s	′
50°	5 3 7	4.6	68° 29′ 0″	373.4	9.64

The work will be as follows:

Tabular hour angle	5^h	3^m	7^s
Correction for increase of 3′ in declination.			14
	5	3	21
Zenith distance (table)	68°	29′	0″
Zenith distance (observed)	62	4	24
Difference	6	24	36

From Table V (A) 6° 24′ 36″ = 6°.409.

First correction = 373ˢ.4 × 6°.409 = 2393ˢ.1 = $39^m\ 53^s$.

And from Table II (B) "Second Correction" for latitude 50°, approximate distance in hour angle 40^m, is 7^s.

Thus we have:

Tabular hour angle	5^h	3^m	21^s	
Sum of corrections		40	0	
Hour angle	4	23	21	(East)

or $19^h\ 36^m\ 39^s$, which agrees exactly with logarithmic calculation.

Next, let us suppose that with the same data from tables, the hour angle $4^h\ 23^m\ 21^s$ being assumed, it is required to find zenith distance.

Corrected hour angle (from table).....	5^h	3^m	21^s
Assumed hour angle	4	23	21
Difference		40	0

First correction $= 9'.64 \times 40 = 385'.6 = 6°\ 25'\ 36''$.

Second correction (from Table II C) for latitude 50°, distance in hour angle $40^m = 1'\ 9''$.

Difference of corrections $= 6°\ 24'\ 27''$.

Whence zenith distance required $= 68°\ 29'\ 0'' - 6°\ 24'\ 27''$
$= 62°\ 4'\ 33''$.

This application of the tables to the problem of finding the zenith distance corresponding to a given hour angle is of particular importance, because it is the calculation of zenith distances which forms the basis of the system of navigation known by the name of Marcq St. Hilaire, which is extensively practiced both in the English and French navies, and which promises sooner or later to come into very general use.

Reverting to the particular problem of finding stars available near prime vertical for the second assumed latitude, viz., 10° N., we have from the Almanac mean time of sunset on August 6 $6^h\ 18^m$. Adding R. A. mean sun $15^h\ 1^m$ we obtain sidereal time of sunset $21^h\ 19^m$, and one hour later sidereal time will be $22^h\ 19^m$.

From the extract from Table I (A) given above it will be seen that in latitude 10° N., nearly all the stars tabulated fail to cross the prime vertical, or do so at an altitude greater than 60°, the limit adopted for the tables. In the present case, however, we find Altair passing the prime vertical to westward at $21^h\ 49^m$ with a zenith distance of 30° 22′, and at any sidereal time between 22^h and 23^h will be available for observation.

But in these low latitudes we have not to trust solely or mainly to stars near the prime vertical, for it is here that the position of "Maximum Azimuth" can be turned to practical account. We now resort to Table I (C), the extract from which will be as follows:

Approximate Sidereal Time of Maximum Azimuth.

(Angle of Position = 90°.)

	Latitude East		10° N. West	
α Andromedæ,	19^h	19^m	4^h	47^m
α Arietis,	21	40	6	24
Aldebaran,	0	58	8	22
Betelguese,				
Pollux,	2	56	12	22
Regulus,	7	35	12	31
β Leonis,	8	27	15	1
Arcturus,	10	9	18	13
α Coronæ,	10	52	20	10
Altair,				
Markab,	19	49	2	11

From this table it appears that between sidereal times 22^h 0^m and 23^h 0^m we have α Arietis and Aldebaran available near maximum azimuth to eastward, in addition to Altair near prime vertical as previously mentioned.

The actual procedure for finding hour angle from observed zenith distance, or zenith distance corresponding to assumed hour angle, is the same in the case of the maximum azimuth, as for the prime vertical, and no additional example need, therefore, be given. It should be pointed out that no correction is necessary to hour angle for change of declination, since the effect is inappreciable at maximum azimuth.

With respect to the title "Position-Line Star Tables," which has been selected, it may be observed that this was adopted on account of the readiness with which the tables adapt themselves to the position-line methods regarded as indispensable in modern navigation. In the process which has hitherto been most usual, in the case of bodies observed upon large bearings, for finding hour angle of the body, and thence longitude of place, much time and trouble are saved by the use of the tables, but when the St. Hilaire method of calculated altitudes is employed, and it is quite likely that this may some day be the generally accepted method,

the simplification effected by use of the tables is even more considerable. It should be noticed, too, that the tables being calculated for intervals of 20′ in latitude no interpolation is required, since the latitude by account will never differ by more than 10′ from a value given in the tables.

The publication of the earlier paper in the PROCEEDINGS OF THE UNITED STATES NAVAL INSTITUTE in December, 1905, has enabled the author to submit his notions to some of the most distinguished living authorities on Nautical Astronomy in England and other countries, with the result of eliciting a most gratifying consensus of opinion as to the probable utility of the tables, and the soundness of the principles on which they are based. These favorable judgments inspire some hope that the work will commend itself also to the practical navigator. Should this prove to be the case the objects which have been kept in view, of diminishing labor of computation, and extending the practice of star observations, will have been fully accomplished, and the time and trouble devoted to the calculation of the tables will not be without result.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE INHERENT TACTICAL QUALITIES OF ALL-BIG-GUN, ONE-CALIBER BATTLESHIPS OF HIGH SPEED, LARGE DISPLACEMENT AND GUN-POWER.

By LIEUTENANT-COMMANDER WM. S. SIMS, U. S. Navy,

Inspector of Target Practice.

In the Proceedings of the Naval Institute for June, 1906, in an article entitled: "Reflections, Historic and Other, Suggested by the Battle of the Japan Sea," Captain A. T. Mahan, U. S. Navy, retired, has stated his conclusions concerning the characteristics of men-of-war best suited for increasing a nation's naval power—assuming a certain limit of expenditure for new vessels.

These conclusions are, I believe, opposed to those reached by practically all naval officers who have given this subject serious consideration; but so great is the weight of Captain Mahan's opinions, that they would doubtless be accepted by those who may not be in possession of certain recently acquired information, which bears with such directness and force upon the question of the fighting qualities of battleships as apparently to demonstrate that Captain Mahan's conclusions thereon are in error.

In the following analysis of this question, I will endeavor to show that this information is of such a fundamental nature as to necessitate a re-examination of both old and new facts, from a point of view differing widely from that taken by Captain Mahan, concerning the qualities of the design that will permit the development of the maximum concentration of effective gun-fire, that is, a fleet's maximum concentration of *hits*.

In the first place I beg to express the opinion that if, when Captain Mahan wrote his article, he had been in possession of certain important information that has since become available, his

conclusions would have been considerably modified; and while I would not presume to oppose his views as to the conclusions to be drawn from the facts as he has assumed them, and as he understands them, still, I feel that I am justified in restating these facts, as I understand them, in the light of the new evidence above referred to, and basing thereon my conclusions.

Captain Mahan's principal conclusions may be summarized, briefly, as follows:

1. That, in designing battleships of a certain displacement, we are never justified in increasing the speed, within reasonable limits, at the expense of the equivalent weight in gun-power.

2. That we are not justified in substituting heavy turret guns, such as 12-inch, for the equivalent weight of the usual intermediate guns, 6-inch, etc. In other words, that the all-big-gun ship is a mistake.

3. That, considering the necessary limit of expenditures, and the requirements of a navy with wide naval responsibility, we should not materially increase the size of the ships now being designed.

These conclusions are admittedly derived from, or supported by, an analysis of the available information concerning the battle of the Sea of Japan, and also upon an analysis of the battle efficiency of guns of various calibers, based upon Captain Mahan's ideas upon the subject.

In reference to this important battle, Captain Mahan has stated that many details are wanting, and probably can never be supplied, the drama having passed too rapidly, and the actors having been too busily occupied, to take precise notes.

Fortunately, this is no longer true, for in the same number of the Naval Institute in which Captain Mahan's article appears there is published a very important paper, giving a history of this battle, that is founded upon very precise notes. The author of this paper, Lieutenant R. D. White, U. S. N., is a distinguished gunnery officer who was, at my request, recently assigned to duty as my assistant. I am therefore informed as to the manner in which his information was obtained; and while I am not at liberty to state more in this respect than Mr. White has thought proper to give in the introductory note that precedes his article, still I may state that his plan, or chart, of the battle (herewith reproduced) was drawn to scale from the very full data (bearings,

distances, and speeds) supplied by the Russian observer indicated, who also gave him the other important information contained in the article—the acquisition of all of this information fortunately being facilitated by a continuous and intimate association of two or three weeks with the observer in question, whose competence is fully established by Mr. White's testimony.

As this officer was a naval constructor, "having no station in battle, he was selected to observe and record the events of the battle," I think it may therefore be fairly assumed that Mr. White's article gives the history of this action with greater precision than that with which any naval battle has ever before been reported; and that we may therefore rely upon the main facts contained in his account.

Assuming that Lieutenant's White's account of the battle in question is substantially correct, it follows that much of the information upon which Captain Mahan has based his conclusions is in error to a greater or less degree. The errors in some cases are not important, but in others they appear to be in effect diametrically opposed to the truth.

For example, taking these errors as they come, Captain Mahan has assumed that, shortly after the Russian and Japanese fleets sighted each other, the Japanese changed course from SW to East, while the Russians were steering about NE, and that the Japanese speed was slower than that of the Russian—"2 or 3 miles to the Russian 4." Under these conditions, that is, with the courses and speeds assumed, the rate of change of range would have been very rapid, and therefore very little hitting could have been done. As a matter of fact, the Russians were steering about NNE, and the Japanese, after turning from SW to East, took a course nearly parallel to them, on their port bow. Thus, the rate of change of range was rendered small, the Japanese fire was concentrated upon the head of the Russian column, and was so effective that the *Suvaroff* was driven out of the line and the *Osliabia* sunk by the time the Russians had advanced about five miles.

The above shows that the nature of the action was rather different from that which Captain Mahan's information led him to suppose. It is therefore unnecessary to follow out the details of the reasoning by which he assumes that Admiral Togo was influenced in taking a position (across the head of the enemy's

column) which he did not take; but it is important to point out that the Japanese admiral's plan of action was what we would have supposed it to be, in the light of our present knowledge of the conditions necessary to the most effective hitting at long ranges.

In the first place it may be confidently assumed that Togo was in possession of the following important facts:

1. That his fleet speed was considerably greater than that of his enemy—the bottoms of his ships being clean and theirs foul, and there being slower ships in the Russian fleet than in his.

2. That his marksmanship was superior to that of the Russians.

3. That Russian gunnery training had for years been carried out with the object of bringing an enemy to close quarters, and that, even assuming that they had profited by their experience in the actions off Port Arthur, the Baltic fleet could not have had adequate training in long-range firing.

4. That, in order to render effective the tactics indicated above, the Russian ships were heavily armed and their crews trained for rapidity of fire.

The above being true, it is clear that Admiral Togo must have gone into action with two principal objects clearly defined in his mind, namely:

1. Fight at the maximum range at which actual experience at battle practices had shown him that he could do effective hitting (about 6000 yards), and at which he knew that the Russian fire would not be dangerous.

2. So maneuver as to maintain the least practicable rate of change of range while concentrating his fire as frequently as possible upon the head of the enemy's column.

If he had not been able to accomplish these two objects he might still have won the battle, because the Russians were so very inferior in many other respects, but he certainly would have suffered more. For example, if the Russians had been able, by superior speed, to run in to 1800 yards (the battle range of their choice), they would have made a large percentage of hits, and these hits would have been very effective, especially from their modern ships of French design (*Suvaroff, Alexander III, Borodino, Orel*).

A glance at Lieutenant White's chart will show, however, that

the Japanese admiral had no difficulty (barring thick weather) in repeatedly choosing his own position (distance and bearing) with reference to the head of the enemy's fleet, and that the battle therefore resolved itself into a competition between the fire-control officers of the two fleets as to which could make the most hits, under the conditions selected by the Japanese—these conditions being of course very unequal, since the Japanese were able frequently to concentrate the fire of many ships upon a few of the Russians.

Let us now consider the manifest object of the Russian admiral's strategy and tactics, with a view of determining why he was unable to succeed.

In the first place, we know, from a certain unpublished report, based upon indisputable authority (and which is practically confirmed by Lieutenant White's report), that the Rusian battleships were so overloaded with stores and coal that the upper edges of their heavy armor belts were well below the water-line (and that therefore, in so far as hull protection was concerned, they were armored cruisers and not battleships); also that compartments, cabins, passages, etc., were so filled with coal and stores that the men's water-closets and urinals had been blocked since leaving Saigon, and that the decks were in consequence in an indescribable condition.

We may, therefore, safely assume that the Russian admiral approached the Tsushima Straits with two objects uppermost in his mind, namely:

1. The most important was to elude the Japanese and take shelter in Vladivostok until he could land his stores, dock and refit his ships.

2. If forced to fight, to do so at the shortest range possible, where most of his shots would count.

He was defeated in both of these objects solely by the superior speed of the Japanese; assuming, of course, that he could not pass through the Straits without being detected. Once he was sighted by the Japanese, which was inevitable, their superior speed (which as shown later, was 6 to 7 knots greater than that of the Russians) rendered impossible his escape without fighting; and, as previously shown, this superiority of speed enabled the Japanese repeatedly to concentrate upon his leading ships, and thus destroy or disable them one at a time—or force them to accept defeat in a worse

form, namely, by abandoning their attempt to reach Vladivostok, thus surrendering the command of the sea without inflicting any damage upon the enemy.

It is, of course, understood that, assuming all other qualities to be equal, a relatively small superiority of speed cannot alone determine a victory by gun-fire, under the usual "game-board" conditions; that is, where sea room is unlimited; where it is always daylight; where thick weather does not act as an occasional screen; where the slow fleet is not embarrassed by having to get anywhere in particular; where there is no convoy or fleet of essential auxiliaries to lose in case of retreat, etc.

In this case the slow fleet can prevent the fast one from taking up a position of continuous advantage, by simply keeping the head of the enemy's column abeam—thus steaming on the arc of a circle of sufficiently smaller radius to counteract the superiority of speed of the fast fleet.

The sole tactical ability of the slow fleet is a negative one—one of equality only, as regards gun-fire; it can never attain an advantage of position, assuming equal skill on both sides; its tactical ability exists only in the open sea; and, even then, the fast fleet always has the great advantage of being able to:

(1) Refuse or accept battle.

(2) Choose his own range.

(3) Control the rate of change of range.

(4) Control the compass bearing, thus taking advantage of the weather conditions that favor his own gun-fire.

That is to say, always assuming equal tactical skill, the slow fleet can neither gain an advantage nor accomplish a definite object, while a fleet that is slightly faster can:

(1) Bring the slow one to action, or refrain from so doing until the conditions suit him, or until he has made such disposition of his forces or auxiliaries as he pleases.

(2) Can choose his own range, and change it at will.

(3) Can close to fighting range when the wind and sea and sun are in the most advantageous positions for increasing the efficiency of his own gun-fire, withdrawing outside of effective range when these conditions become unfavorable to him.

It follows from the above that the slow fleet must always fight at a disadvantage, even in the open sea; and that when restricted in its movements by the neighborhood of land or shoal water, by

the necessity of protecting essential auxiliaries, by the necessity of reaching a definite point, or by the necessity of leaving a port in the face of a blockading enemy, it must inevitably be defeated by a faster fleet of equal power, and can be defeated even by a faster fleet of less power.

For example, twelve 16-knot vessels could be blockaded by a less number of 20-knot, or even 18-knot, vessels of the same individual gun-power, even assuming that the latter would refrain from attacking until the former were all outside and formed for battle, because the blockaded vessels would, on coming out, be caught between the land and the enemy, and thus forced to steer a practically straight course, while the faster fleet could, while keeping outside of effective range, draw ahead and then close in with a concentrated fire on the head of the column—or the stern of the column, if it reversed its course.

The blockaded fleet would be constrained to try and reach the open sea (in the same manner that the Russian squadron was constrained to continue northward, sooner or later, through the Tsushima Straits), and would suffer defeat in the process, by reason of the ability of the faster fleet repeatedly to assume positions enabling it to concentrate its fire on the extremities of the enemy's fleet.

Incidentally, it should also be noted that a fleet of small vessels would have a considerably less coal endurance than a fleet of large ones, when both are maneuvering at the speed of the former, and that the fleet of large vessels, while avoiding decisive action and preventing its enemy from proceeding in any given direction, can ultimately attack when the latter is obliged to abandon the open sea.

If, therefore, a fast fleet can defeat a slow one under all circumstances except when the latter is entirely unrestricted in its movements, it seems clear that no nation would be justified in deliberately building a slow fleet having the above enumerated dangerous disadvantages; that is, a fleet that would be practically certain of defeat whenever the exigencies of its service in war brought it in contact with an enemy of equal force while in the neighborhood of land, or while restricted in its movements by the nature of its service or from any other cause.

From the above it seems clear that, in the light of our present knowledge of the fundamental principles of long-range gun-fire,

a superiority of speed that will enable a fleet frequently to concentrate its fire on an enemy that is not entirely unrestricted in its movements, as above explained, is more important than the additional guns corresponding to the weight (in boilers and engines) required to give this superiority in speed.

Captain Mahan assumed that the Russian fleet maintained "on May 27 a fleet-speed of at least twelve knots, while the Japanese seem not to have used more than 15." Lieutenant White's informant states that the Russian fleet speed was 9 knots, and the Russians estimated the Japanese speed as 16 knots. As Mr. White's chart is a chart, plotted to scale from the precise data taken by his informant, and not simply a diagram to illustrate his text, it follows that if we measure the distances steamed by the two fleets, from 1.55 p. m. to 6.25 p. m. (4.5 hours), and divide these distances by this elapsed time, the results will be the fleet speeds—though the calculation will be rough, as the scale of the chart is small. This calculation shows that, during the 4.5 hours, the Russians steamed 40 miles while the Japanese steamed 68, which gives the average speed of the former, as a little less than 9 knots and that of the latter as a little more than 15. It should be noted, however, that the Japanese speed "alternated 0 to 16 knots" between 3.40 and 4.15, therefore their fleet speed was probably considerably more than 15 knots.

The Japanese superiority in speed was therefore more than six knots, an advantage so enormous that no conceivable strategical or tactical skill, and no possible augmentation of gun-fire (without increasing the displacement) on the part of the Russians, could have prevented their defeat, even supposing but a rudimentary knowledge of strategy and tactics on the part of the Japanese admiral, and assuming, of course, that the Russian fleet was constrained to force its way sooner or later through the Straits.

Before leaving this question of speed, it may be well to point out that if the speeds of the Japanese and Russian fleets had been reversed, Admiral Togo could not possibly have prevented the Russians (1) escaping to Vladivostok, or (2) bringing the Japanese to battle at short range—if they had so desired. This is clear by a reference to Mr. White's chart. For example, at 1.55 p. m. the head of the Japanese column bore about WNW from the Russian flagship, distant about 3.5 miles, so that the Russian ships, by steering an easterly course, could have left the Japanese

out of sight astern, and then, hauling to the northward, could have gained Vladivostok.

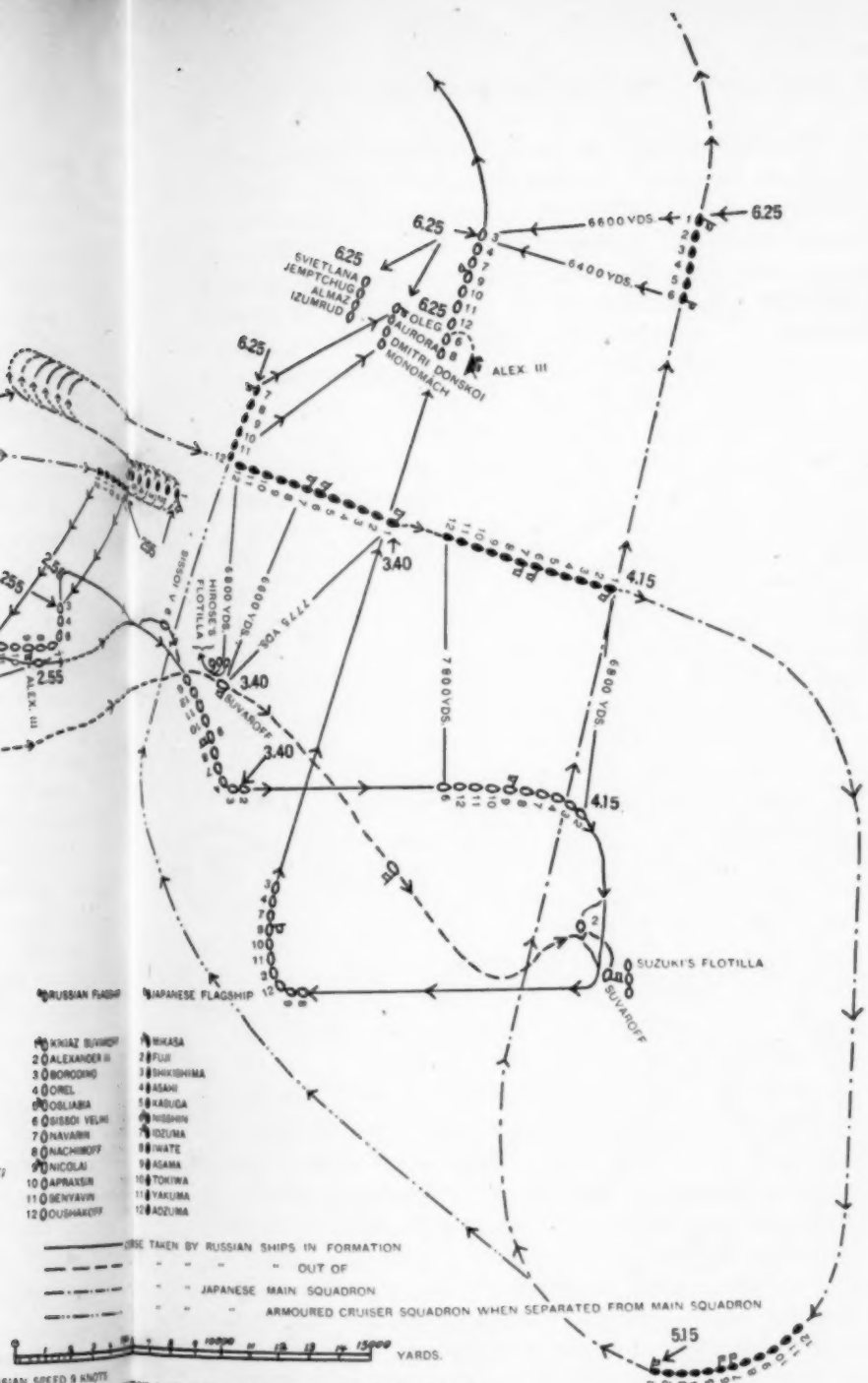
Furthermore, Admiral Togo's comparatively easy strategy would have been so modified by a reversal of the speed conditions, that he would have been obliged to await the Russians off Vladivostok, out of range of the outer forts, in a region of frequent and dense fogs, and do them what damage he could as they passed in.

It may also be pointed out that, shortly after 4.15 p. m. (see the chart), the Japanese lost sight of the Russians, due to thick weather, and steamed seven or eight miles to the southward in search of them, and when they turned to the northward in pursuit, they were about 10 miles astern; therefore, if the Russians had had even one-quarter of a knot superiority in speed, they would have arrived at Vladivostok a couple of hours ahead of their pursuers.

It is of course admitted that the superior speed of [illegible] ships cannot at once be fully utilized while in fleet formation with slower ones, and that it would be very convenient if all nations would decide not to exceed a certain speed in the design of new vessels. But since such an agreement is probably impracticable; since at present they insist upon building large, 20-knot battleships, should we build 16-knot ships with about one-half the heavy gun-power? To do so would mean that, 25 years hence, when most of the existing ships will be on the scrap-heap, we would still have a 16-knot fleet, while our possible enemies would have 20-knot fleets of large vessels each with about twice as much gun-power. We would have more vessels—a longer fleet—but that would avail us nothing against an enemy having units of about double the gun-power concentrated in a fleet about one-half the length of ours, and with the necessary speed frequently to take up positions of advantage, thereby enabling them further to concentrate their fire, whenever the maneuvers of the enemy were restricted by any of the causes above mentioned.

Manifestly, one of the very greatest advantages afforded by large vessels is a tactical one, namely, the inherent ability to concentrate double the gun-power in a line of battle about one-half as long as that necessarily required for ships of about one-half the heavy gun-power; but this can best be explained after discussing the advantages of large vessels from the point of view of the control of gun-fire alone.

N
2.30
3.08
2.55
2.55
2.30
9600 YDS.
8100 YDS.
8000 YDS
SUVAROFF
ALEX. III
OSLIABIA
1.55
6800 YDS
7000 YDS.
1.55
1.38
SUVAROFF—RODJESTVENSKI
ALEXANDER III
BORODINO
OREL
1.38
OSLIABIA—FOUNTAINSHAM
SISSOI VELIKI
NAVARIN
NACHIMOFF
NICOLAI-NEBOGATOFF
APRAXSIN
SENYAVIN
OUSHAKOFF
RUSSIAN FLAGSHIP
KNIAZ SUWAROFF
ALEXANDER III
BORODINO
OREL
OSLIABIA
SISSOI VELIKI
NAVARIN
NACHIMOFF
NICOLAI
APRAXSIN
SENYAVIN
OUSHAKOFF
YARDS.
RUSSIAN SPEED 9 KNOTS
JAPANESE " 18 "



SIAN SPEED 9 KNOTS
ANESE " 10 " FROM 3.40 TO 4.15 WHEN IT ALTERNATED 0 AND 16 KNOTS

It is true that the speed of a fleet may be reduced by damage to the motive power of one of its units, but this has very rarely happened, because engines, boilers, etc., are below the water-line, and well protected by the heaviest armor. Captain Mahan lays great stress upon the alleged effect of the loss of funnels, or smoke pipes, saying that the resulting loss of speed would be so great that "The loss of a modern funnel will be like the loss of a former-day mast." This appears to me to be a great exaggeration. As I understand this matter, the principal reason for building a tall funnel is to increase the natural draft, and thus render steaming more economical in time of peace. With lower funnels the natural draft is smaller, as the column of hot air is shorter, and this necessitates the use of forced- or "assisted-" draft during ordinary cruising. Tall funnels have always been a mistake, from a military point of view, because when a vessel having them goes into battle, and forced draft is put on to develop her maximum speed, the tall funnel adds very little to the draft, by reason of its height. It has been reported that the British ship *Edgar* lost two of her funnels in a gale of wind without any material diminution in her speed. If, therefore, we should be obliged to go into battle with our present absurdly high funnels, we may regard their being shot away, or riddled with holes, with comparative equanimity (provided they do not fall on deck and disable guns), since in either case the draft will not be materially decreased—as a high funnel corresponds to a pressure of about one-half an inch of water, whereas blowers will create a pressure corresponding to about two inches of water.

It may be well to notice, moreover, that the requirements of fire-control necessitate much shorter funnels, because gun-fire can be controlled efficiently only from elevated platforms on the masts (about 100 feet from the water), and as funnels cannot be made high enough to carry the smoke over these platforms they must be made so low that the smoke will not reach them. It is for this reason that experienced gunnery-officers now recommend short funnels—and I believe that such funnels will be a feature of our new designs.

Concerning the advisability of building all-big-gun ships, that is, discarding all smaller guns (except torpedo-defense guns) and designing the ships to carry the maximum number of heavy turret guns, these alone to be used in battle against other ships,

I think it could be clearly shown that Captain Mahan is in error in concluding that it would add more to our naval strength to expend the same amount of money that the big ships would cost, for smaller and slower ships, carrying the usual intermediate guns (6-inch, etc.); and that, as in the question of speed, this error is due to the fact that much important information concerning the new methods of gun-fire was not considered by the author in preparing his article.

NOTE.—Unfortunately, these methods of gun-fire cannot at present be specifically explained in a published article, as this would involve a discussion of our methods of controlling our ships' batteries and bringing our ships into action with an enemy.

I may, however, assure the reader that, from the point of view of the efficiency of gun-fire alone, it would be unwise ever to build a man-of-war, of any type whatever, having more than one caliber of gun in her main battery. In other words, it may be stated that the abandonment of mixed-battery ships in favor of the all-big-gun, one-caliber ship was directly caused by the recognition of certain fundamental principles of naval marksmanship developed by gunnery officers.

Therefore we have but to decide what the caliber for each class of ships should be, a decision which should present no special difficulty, provided it be first determined how we are to defeat the enemy—whether by the destruction of his ships (by sinking them or disabling their guns) or by the destruction or demoralization of their personnel.

In this connection the following facts should first be clearly understood, namely:

1. Turrets are now, for the first time, being designed that are practically invulnerable to all except heavy projectiles. Instead of having sighting-hoods on the turret roof, where sights, pointers, and officers are exposed to disablement (as frequently happened on the Russian ships) there will be prismatic sights, projecting laterally from the gun trunnions, through small holes in the side walls of the turret, and the gun-ports will be protected by 8-inch armor plates, so arranged that no fragments of shells can enter the turrets.

2. On the proposed all-big-gun ships the heavy armor belt will be about 8 feet above the water-line and extending from end to end. The conning-tower, barbettes, etc., will be of heavy armor;

and there being no intermediate battery (which could not be protected by heavy armor, on account of its extent), it follows that in battle all of the gunnery personnel, except the small, single fire-control party aloft, will be behind heavy armor, and that, therefore, neither the ship nor her personnel can be materially injured by small caliber guns.

Considering, therefore, that our object in designing a battleship is that she may be able to meet those of our possible enemies upon at least equal terms, it seems evident that it would be extremely unwise to equip our new ships with a large number of small guns that are incapable of inflicting material damage upon the all-big-gun, one-caliber ships of our enemies, or upon the personnel manning their guns.

Captain Mahan states that it has long been his opinion that the so-called secondary battery is really entitled to the name primary, because its effect is exerted mainly upon the personnel, rather than the material of a vessel. I believe that it can be shown that this opinion is based upon certain mistaken assumptions in regard to the efficiency of these guns. But in order to avoid possible confusion, let me first state that Captain Mahan uses the term "secondary battery" to indicate guns of "6 to 8-inch," whereas our present official designation of the various classes of guns is as follows: Heavy guns, 8-inch to 13-inch, inclusive; intermediate guns, 7-inch to 4-inch, inclusive; secondary guns, all those of 3-inch caliber or less.

For example, at 6000 yards, a 12-inch gun, having an initial velocity of 2400 feet per second, has an angle of fall of 4.75 degrees, while that of a 6-inch gun, having the same velocity, is 8.50 degrees; and the respective danger spaces, for a target 30 feet high, are 120 and 64 yards.

This illustrates how much more difficult it is to hit with the 6-inch than the 12-inch gun, and makes it clear, I believe, that Captain Mahan is greatly in error in saying that if we determine the number of shots fired by each caliber we may assume a "probability of a proportionate number of hits."

As a matter of fact, Captain Mahan has drawn his conclusions from the "volume of fire" of the different calibers instead of from their volume of hitting, or "*rapidity of hitting*," which is the only true standard of efficiency for all kinds of gun-fire. He has also assumed that the Japanese rapidity of 6-inch fire was

about four times as great as that of the 12-inch fire, when, as a matter of fact, it was probably not much more than twice as great. We have, of course, no actual figures, but as we know that 12-inch guns can fire two shots per minute (and with improved loading-gear, this rapidity will be increased), and that 6-inch controlled firing is at the rate of four shots per minute, and as we also know that since 1901 the Japanese have used the most modern methods of training, we may safely assume that the relation between their 6-inch and 12-inch rapidity of fire is about as above stated, though both calibers may be actually less, or more, rapid.

Referring, however, to Lieutenant White's article, page 613, we may form a tolerably fair estimate of the relative *rapidity of hitting* of the 12-inch and 6-inch guns. He estimates that the Japanese fired 1275 heavy shell (12-inch) and made 250 hits, or 19.6%, which was good shooting, considering the long ranges and the unfavorable weather. As for the "90 odd secondary guns" (Captain Mahan's estimate), if we assume that, on an average, each fired 2½ times as many shots as each 12-inch gun, the total number of shots was 16,875 (2.5 times 75 times 90). If they had made a "proportionate number of hits," or 19.6%, they would have scored 3307 hits, or about 13 times as many as the 12-inch hits, which we know they did not make.

Unfortunately we cannot obtain the exact figures, though we can make an estimate that will be close enough to show the comparative hitting capacity of these guns. For example, the *Orel* "was struck 42 times by 12-inch shells and over 100 by 6-inch and 8-inch shells." She was fourth in the line at the beginning of the action, and second at the end, therefore she at no time received the brunt of the Japanese fire, which was directed principally at the leading vessel. This accounts for the comparatively small number of 12-inch hits that this vessel received. We know that after her guns were disabled, she was pounded by minor cruisers, having 6-inch and 8-inch guns, and that at one stage of the action (2.55 p. m.) she sustained the fire of six armored cruisers at a range of less than 5000 yards. We may therefore fairly conclude that she received more 6-inch and 8-inch hits than any other vessel.

We will assume, however, that the *Suvaroff* received as many. This vessel was fearfully exposed, first at the beginning of the

action, and again at 3.40 p. m., when she sustained the concentrated fire of 12 battleships and cruisers, which accounts for her being "struck over 100 times by 12-inch shells alone." Assuming, therefore, that the *Alexander III, Borodino,* and *Osliabia* each received fifty 6-inch and 8-inch hits, we have a total of 350 hits out of 16,875 shots, or 2.1%. That is to say, they fired 50 pounds of the smaller projectiles for every pound that hit, whereas they fired only 5 pounds of 12-inch metal for every pound that hit—which accords with the law that we have deduced from our target practices, namely, that the smaller the gun the more projectiles you must waste to make a hit; but as the Japanese battleships and armored cruisers carried these guns they were of course justified in firing them—as best they could without diminishing the rapidity of the 12-inch guns. They did not, however, fire any of their small guns—those less than 6-inch—because to do so would have caused too much "interference" with more important guns; though the "hail" of small projectiles, that is so popular in newspaper accounts, would have been very effective—if the shots had hit.

Let us now consider what would have been the probable effect if the designers of the Japanese battleships had installed as many 12-inch turret guns as possible in place of the 40 small guns. They could doubtless have mounted one turret forward and two turrets aft on the center line, or vice versa, thus increasing the heavy broadside fire by 50%, that is six 12-inch guns instead of four. The result would have been 125 more 12-inch hits. Similarly, if the cruisers had been designed to carry heavy guns only, they could doubtless each have mounted at least four heavy turret guns of, say, 10-inch or 11-inch caliber, thus substituting 32 heavy turret guns in place of all of their 6-inch and 8-inch guns. The result would have been 500 more heavy-gun hits which, added to the 125 additional hits made by the battleships, make in all 625 heavy-gun hits in place of the 350 hits by 6-inch and 8-inch guns.

In other words, if the Japanese vessels had been designed in accordance with the principles of modern gun-fire (had been all-big-gun ships), their fleet would have developed a greater rapidity of hitting with heavy guns (875 hits) than it actually did develop with 12-inch, 8-inch, and 6-inch guns (700 hits)—and this for the simple reason that, at long ranges, the hitting capacity of their

heavy guns was 19.6% while that of the small guns was only 2.1%. Moreover, as a matter of fact, a fleet having but one caliber of heavy guns on each vessel, would have been able to make still more hits in a given time, because their fire-control officers would not have suffered from the "interference" (delay) caused by the more numerous discharges of the smaller guns.

Thus we see that, at modern battle ranges, an all-big-gun fleet will actually deliver a greater *volume of hitting*—a greater number of hits, twice the weight of metal hitting, and twice the weight in bursting charges—than a fleet of mixed-battery ships of the same nominal power.

As for the comparative moral effect of the explosion of 12-inch and 6-inch shells, it seems to me that when we compare the difference in weight of the bursting charges (that of the 12-inch is 38 lbs. while the 6-inch is only 4 lbs.) and the difference in the strength of the walls of the shell, there can be no doubt that the moral effect of the former is very much greater than that of the latter.

As reliable evidence of this effect I may cite the testimony of Captain Semenoff, as reported editorially in the Boston Herald of September 3, 1906.

"He appears from his statements to have occupied the position on the Baltic fleet of a trained observer having no official duties to perform, but simply to make notes, and from shortly after noon on the 27th of May until 7.40 p. m., when, in consequence of wounds, he was compelled to abandon his post, he had nothing to do but to watch and record the events of the battle, ... as seen by him from the rear bridge of the battleship *Suvaroff*, Admiral Rodjestvensky's flagship."

"After fire had been opened between the combatants, Capt. Semenoff was struck by the fact that the 4-foot shells (12-inch) of the Japanese invariably burst on hitting the water, but the moment they obtained the range that the effect of their fire was terrific. A young lieutenant came up and asked him if this recalled his previous experience of August 10, at which time the *Czarevitch* was hit nineteen times by heavy shells in the course of several hours fighting. In order to keep up the courage of the inquirer, Captain Semenoff said, 'Yes,' but his real opinion was that he had never seen or imagined such accuracy of fire, the shells coming one after another without interruption, and hitting so

frequently that he could not count the number of hits. (This was doubtless at 1.55 and at 2.30 p. m., when practically the whole of the Japanese fire of 12 ships was concentrated on the *Suvaroff*. Wm. S. S.). The force of their explosion was so great that it seemed to him that mines were exploding under the deck or against the ship's side." . . . . "At 3.20 p. m., about an hour and a half from the time the first gun was fired Captain Semenoff was obliged to record in his note-book that the battle was lost."

If they were 6-inch shells that made Captain Semenoff think that "mines were exploding" it is probable that 12-inch shells would have impressed him as being earthquakes, and that he would accordingly have made special mention of the fact.

If it be admitted, from a consideration of the necessities of modern gunnery, that it would "be unwise ever to build a man-of-war, of any type whatever, having more than one caliber of guns in her main battery," and if it be admitted that the heavier the shell the greater the percentage of hits, and the greater its effect in disabling ships and demoralizing their personnels, it is evident that these guns should be of the smallest caliber that will do the work required, because the smaller the caliber the more ammunition can be carried. As the object of building a battleship is that she may meet her possible enemies on at least equal terms, it follows that the caliber of her guns must necessarily be governed by the thickness and character of the armor protection of these enemies. If an 11-inch 50-caliber gun is large enough to answer the purpose it should be adopted.

This is, however, a matter of detail. The essential principle of a ship's battery is, from the point of view of the modern gunnery officer, that all of her battle guns be of the same caliber.

But, it may be asked, if this is true now, has it not always been true? And how can we account for the fact that, until recently, practically all naval officers have favored ships with two or more calibers of main-battery guns? The explanation is afforded by a former erroneous belief, namely, that it was not considered advisable to increase the number of heavy guns on battleships, because the greater the caliber of the guns the less their hitting capacity, due to the weight to be handled in aiming, etc. While this may have been true to a certain extent during the time when most navies paid practically no intelligent attention to shooting, it ceased to be true as soon as the present competitive system of

training developed the real hitting capacity of these guns, thus reversing this supposed law and showing that the true law was, as should have been recognized, in perfect accord with the ballistic properties of the various calibers.

Referring, now, to a point previously indicated, but not explained, I beg to invite special attention to the tactical advantage that we shall gain by having battleships of large displacement—an advantage which appears to me so great as entirely to outweigh all of the alleged advantages of numbers, mentioned by Captain Mahan. This may best be illustrated by contrasting the tactical qualities of two fleets, one of large vessels and one of small.

Before doing so, however, it may be well to state my understanding of the principal tactical qualities that are desirable in a fleet. These are:

1. The compactness of the battle formation.

2. The flexibility of the fleet as a unit, that is, its ability to change its formation in the least possible time and space with safety to its units.

For example, suppose two fleets of eight vessels each, composed of ships that are alike in all respects, and suppose their personnel to be equally skillful, with the exception of the Commanders-in-Chief, whose difference in energy and ability is such that one fleet has been so drilled as to be able to maneuver with precision and safety while maintaining one-half the distance between its units that the other fleet requires.

This is putting the extreme case, but it shows:

1. That the short fleet, being about half the length of the other one, can complete certain important maneuvers (such as Admiral Togo performed at 1.55 p. m. and 2.55 p. m.), in about one-half the time and one-half the space required for similar maneuvers of the long fleet.

2. That, when ranged alongside each other, as shown in Fig. 1, the defeat of the long fleet is inevitable, since the rapidity of hitting of the individual units is assumed to be equal, and each of the four leading ships of the long fleet receives about twice as many hits as she can return, though the eighth ship of the short fleet would suffer a preponderance of gun-fire from the 5th or 6th vessel of the long fleet—the 7th and 8th being too far astern to do much damage, as would also be the case if the long fleet had several more vessels astern of these.

It is because of the principle here illustrated that the constant effort of competent flag-officers is to reduce the distance between the units of their fleets to the minimum that can be maintained with safety under battle conditions; that is, while steaming at full speed, without the aid of stadimeters, sextants, and other appliances that should be used only for preliminary drills.

Doubtless, some flag-officers, by constant competitive exercises in maneuvering may succeed in attaining an interval between ships that is less by 15 or 20 per cent than that attained by others; but manifestly there is hardly any possibility of much greater improvement in this respect, because the minimum practical interval between ships depends upon their lengths and maneuvering qualities. For example, the German interval is 300 meters from center to center, while larger ships, say 400 feet long, require about 400 yards, and those between 450 and 500 feet in length require about 450 yards.

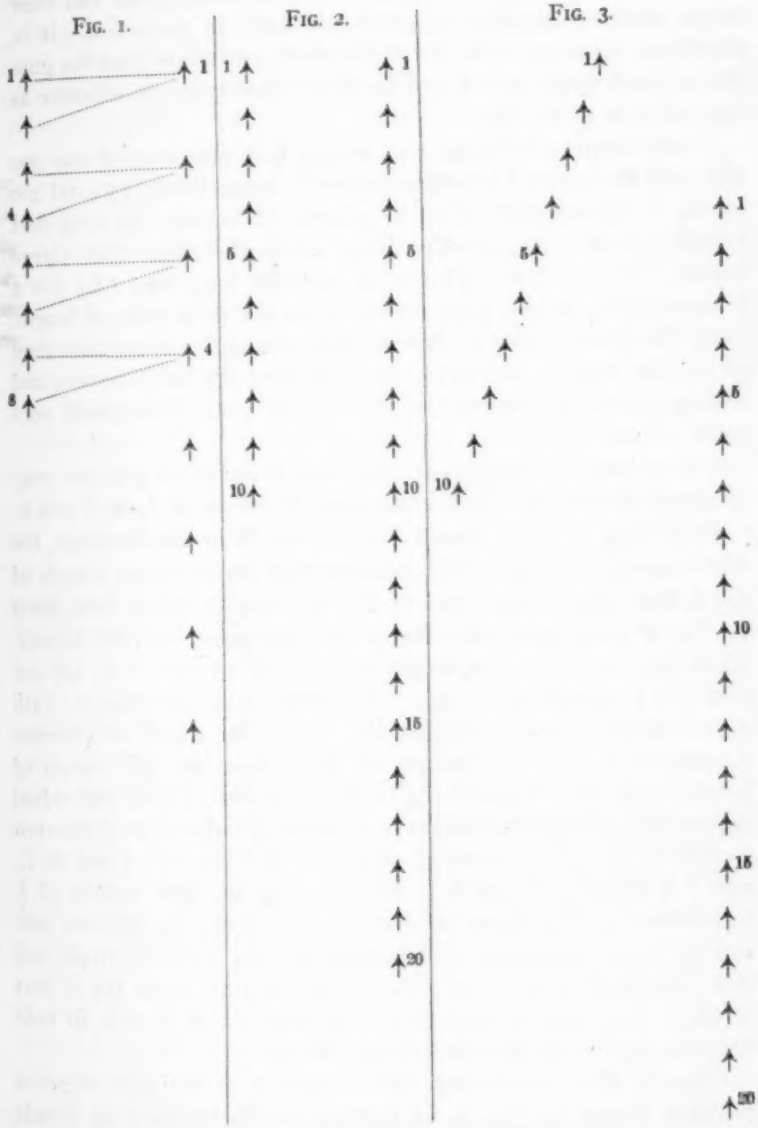
If we accept Captain Mahan's advice and build comparatively small, low-speed battleships, while our possible enemies build large, swift, all-big-gun ships, it seems clear that we will sacrifice the enormous advantages of fleet compactness and flexibility, the superior effect of heavy-gun fire and the ability to concentrate our fire—the loss of these advantages to be fully realized 25 years hence, when our enemies have fleets of big ships while we still have those of our present type.

In order clearly to illustrate the above, I will assume a fleet of ten 20-knot battleships of about 20,000 tons displacement, each having a main-battery of five 12-inch, double-gun turrets, or a broadside fire of eight 12-inch guns, disposed as in the *Dreadnought* type, that is, one turret forward, one on each beam, well forward, and two aft on the center line.

Assume the cost of these ships to be 10 millions each, or 100 million for the fleet, and assume that the same sum of money will build a fleet of 20 battleships (though the number would, in reality, be considerably less) of the smaller type, of, say, 13,000 tons and 16 knots speed, each ship armed with two 12-inch, double-gun turrets, or a broadside of four 12-inch guns, and as many of the smaller guns, recommended by Captain Mahan, as can be mounted upon this displacement.

It is further assumed that, as all of the gun-crews of the fleet of large vessels are behind heavy armor, in the 12-inch turrets of

new design (heretofore described), neither the crews nor the guns can be materially injured by the intermediate guns of the



fleet of small vessels; whereas, on the contrary, the majority of the men composing the gun-crews of the small vessels (all but

about 90, for the two 12-inch turrets and their ammunition supply) are behind the armor of the intermediate guns—necesarily light on account of its great extent—and that these guns and their crews must be disabled or destroyed early in an action. It is, therefore, evidently well within the truth to assume that the gun-fire of each large vessel will be more than twice as effective as that of each small one.

If the length of a large ship is 500 feet, and a small one 400 feet, and the interval between centers is, respectively, 450 and 400 yards, it follows that, when in column of vessels, the long fleet (small vessels) is 3.9 miles long, while the short fleet (large vessels) is 2.1 miles. That is to say, the long fleet (*L*) has a broadside fire of less than 21 big guns for each mile of length, while the short fleet (*S*) has 38 guns per mile—a concentration of gun-fire that is *inherent in the design* of the large vessels, and which no conceivable tactical skill on the part of the small ones could offset.

The tactical advantage of this concentration of gun-fire may be shown graphically by the following diagrams of fleets *S* and *L*.

From Fig. 2, which shows *S* in a position of disadvantage, the rear vessels outflanked, it is apparent that the first nine vessels of the *L* fleet can be destroyed by the first nine of the *S* fleet, since the latter have more than twice the gun-power of the former, while No. 10 *S* can sustain the fire of both 10 and 11 *L*, but not that of 12, 13, and 14 *L*, also. Assuming, however, that the 14th vessel of the *L* fleet is the last one whose fire would be effective against 10 *S*, the rear vessels of the *S* fleet can (by reason of having more than twice the individual gun-fire of their individual opponents) protect themselves by dividing the fire of 10 *S* between 13 and 14 *L*; 9 *S* between 11 and 12 *L*, 8 *S* between 9 and 10 *L*, and 7 *S* between 7 and 8 *L*, thus leaving the first vessels of *L* to be destroyed by twice their gun-power from the first six vessels of *S*; an advantage that is possible only with big ships, and this advantage is of great importance, because when the *S* fleet is taken at a disadvantage it enables each of its vessels to hold her own against at least two of the enemy.

Observe that, even when the *L* fleet is in the advantageous position shown in Fig. 2, no increase in the number of vessels in the *L* fleet can possibly prevent the successive destruction of the leading vessels, since all vessels behind No. 14 are practically out of the action.

Observe, also, that if for any cause the *L* fleet should be restricted in its maneuvers, the *S* fleet, instead of exposing its rear vessels to concentrated fire, as in Fig. 2, would take advantage of its superior speed and assume the position shown in Fig. 3, thus concentrating upon the leading vessels of the *L* fleet its entire gun-fire at a greatly less average range than would be possible if the positions of the fleets were reversed. That is to say, the concentration of the *S* fleet upon the leading vessels of the *L* fleet (Fig. 3) is very much more intense than would be the concentration of *L* upon the leading vessels of *S*.

It would therefore appear that, from a tactical point of view alone, the advantages of large vessels are such that they afford greatly increased offensive power when in a position of advantage and greatly increased defensive power when temporarily in a position of disadvantage.

It should also be noted that if, through an accident to the motive power of a large vessel, the fleet speed of *S* were reduced to that of the *L* fleet, the *S* fleet would still be a superior tactical unit, because it is more compact (is shorter and has less units) and can therefore maneuver with greater ease, and frequently in much less time—an advantage that is in some cases analogous to superior speed.

For example, the time necessary to communicate a signal to the 20 vessels of the *L* fleet, and be sure it is understood, and for this fleet to complete a change of course in column, so as to make a simultaneous movement, would be at least twice as long as that required for the ten vessels of the *S* fleet.

It follows, of course, from the above, that as soon as we build any fast vessels of the large displacement above indicated, and put them in the line of battle with 16-knot ships, we strengthen the fleet much more than if we added as many 16-knot ships as could be built for the cost of the big ships; for though we cannot at once utilize the superior speed of the big ships, we have nevertheless increased the compactness of our fleet, diminished the number of units and, therefore, for the reasons given above, have rendered it a superior tactical unit—which means that, with equal skill, it would out-maneuver a fleet of the same cost composed of small vessels throughout.

It should be noted, also, that if we place two only of these large ships at the head of a column of small vessels, each having

one-half of the broadside fire of the former, we not only render the fleet more flexible, by shortening it my more than 2000 feet, but we strengthen our fleet at the weakest point, by concentrating within a distance of 1800 feet a broadside fire equivalent to that of four vessels occupying a space of 4000 feet. The above advantages are evidently so great that the alleged value of homogenity of units is not worth considering.

Concerning the alleged strategic value of numbers, and assuming that Captain Mahan's statement that: "A nation with wide naval responsibilities must have numbers in proportion" means that we would better spend our available appropriations in building small vessels, rather than large ones, in order to facilitate dispersing them over the world, I beg to say that, in my opinion, the above analysis shows very conclusively that a fleet of the large vessels is greatly superior in fighting value to a fleet of the small ones, no matter into how many equal squadrons (of, say, four or more vessels) we subdivide them.

For example, for 280 millions we could build 28 of the *Dreadnought* class or 40 *Connecticuts,* or four squadrons of 7 and 10 vessels, respectively. The former squadron would be 1.4 miles long, with a broadside fire of 40 12-inch guns per mile, and the latter 2.1 miles long with a broadside fire of 20 12-inch and 20 8-inch (neglecting the smaller guns as not effective against any of the armor of the *Dreadnought* class).

The above assumes that a nation with even the widest naval responsibilities would ever deem it advisable to disperse their naval units throughout the world, even in time of peace, thus diminishing individual efficiency, unity of purpose and action and the indispensable ability to maneuver large fleets at battle speed. (Rodjestvensky's fleet had been maneuvered but once as a fleet before the battle of the sea of Japan).

I had always supposed that the subdivision in time of peace of a nation's fighting units into numerous independent squadrons was due more to personal reasons than to a consideration of the principles of naval training and strategy—which latter seems to be more correctly illustrated by the rapid concentration that takes place when war is imminent. I understand that where the command of the sea is involved, a nation is not deterred from going to war by the state of dispersion of a rival nation's battleships, but by the knowledge that he has a certain number; that they

possess certain material fighting qualities; and that they have been continuously trained to a high degree of individual and fleet efficiency by concentration in one or more large fleets.

It is for the above reasons, I believe, that the Naval War College has for a number of years consistently advocated all-big-gun, one-caliber ships, and the concentration in time of peace of all our heavy fighting ships under one command in the Atlantic, thence to be dispersed in squadrons of the required size to meet the requirements of the situation, after rather than before we know who our enemy is to be.

If it be claimed that it would be better to reduce the speed of the large vessel to 16 knots and put the weight saved into guns, it may be replied that heavy turret guns cannot be mounted to advantage (so as to increase the hitting capacity of the vessel) without very considerably increasing the size of the ship, because the number of heavy turrets that can be placed to advantage is governed largely by the length of the ship—which increases slowly with the displacement. This point is fully discussed in a recent article in a German publication. I do not remember the displacements used by the author to illustrate the principle, but, supposing the ones quoted below to be correct, he shows that if it requires a displacement of 20,000 tons to obtain a broadside fire of, say, eight 12-inch turret guns, you could not advantageously mount any additional turrets on 21,000 or 22,000 tons, but would have to go to 25,000 or 26,000 tons to obtain the necessary space. And, conversely, if you design a 20,000-ton battleship for 16 instead of 20 knots, you cannot utilize the weight saved to increase the gun-power by adding 12-inch turrets—as you could by adding a number of intermediate guns.

It is now hardly necessary to state that adding superimposed turrets (by which the number of guns could be doubled, if the weights permitted) does not materially increase the hitting capacity of the ship as a whole, because of the "interference" caused by having four guns in one two-story turret, while it decreases her defensive power by adding to the vertical height of her vital targets.

Captain Mahan characterizes the sudden inclination in all navies to increase the size of the new battleships (from about 15,000 to about 20,000 tons) as a "wilful premature antiquating of good vessels" . . . . "a growing and wanton evil." If these words

are intended in their true meaning, the statement is to me incomprehensible. I can understand an individual being wilful and wanton, but I cannot believe that the naval officers of the world could, without good cause, be suddenly and uniformly inspired in this manner. On the contrary, it seems to me that the mere fact of there being a common demand for such large vessels, is conclusive evidence that there must be a common cause that is believed to justify the demand.

This common cause is undoubtedly a common belief that the same amount of money expended for large war vessels will add more to a nation's naval power than the same amount expended for smaller vessels; for it cannot reasonably be assumed that the tax-ridden nations of Europe expend their great naval budgets wilfully and wantonly. Undoubtedly each nation earnestly strives so to expend these sums as to derive the greatest increase of naval power. The same is true in reference to their armies. As the mechanical arts improve, each nation endeavors to improve its war material. When a nation adopts new rifles, it is not a wilful premature antiquating of several million excellent ones, it is a case of *force majeure*—it must adopt them or suffer a relative loss of military efficiency; and it must make no mistake as to the relative efficiency of its weapons. In 1870 the French suffered a humiliating defeat as a direct result of the colossal conceit which rendered them incapable of accepting conclusive evidence that the German field artillery was greatly superior to theirs.

The same law—that of necessity—governs the evolution of battleships. As might have been expected, this evolution has, as a rule, been gradual as regards increased displacement. The exception is the recent sudden increase (4000 to 5000 tons) in displacement. This exception therefore needs explanation. As partially indicated heretofore, it was due to a complete change of opinion as to the *hitting capacity* of guns of various calibers. This is now well understood by all officers who have recently been intimately associated with the new methods of gunnery training. These methods have demonstrated this point in such a manner as to leave no doubt in our minds as to the correctness of our conclusions. The rapidity of hitting of the heaviest guns has been increased several thousand per cent, and that of smaller guns about in proportion to their caliber.

(Incidentally, it should never be forgotten that the credit for

the inception of the epoch-making principles of the new methods of training belongs exclusively to Captain (now Rear-Admiral) Percy Scott, Director of Target Practice of the British Navy, who has, I believe, done more in this respect to improve naval marksmanship than all of the naval officers who have given their attention to this matter since the first introduction of rifled cannon on men-of-war—nor should we forget that this degree of improvement was rendered possible by the introduction of telescope sights, the successful application of which to naval guns was made by Commander B. A. Fiske, U. S. Navy, as early as 1892).

As soon as the above facts gained general acceptance in Great Britain and the United States, the evolution of the all-big-gun, one-caliber battleship became a foregone conclusion; and the reason for the great increase in displacement, as I understand it, is simply that you cannot build an efficient ship of this class on less than about 20,000 tons, because you cannot mount more than two 12-inch turrets to advantage upon a battleship of much less displacement, because the length and breadth are not sufficient.

We were obliged to do the best we could in this respect upon 16,000 tons, because Congress fixed that as the maximum "trial" displacement; but the resulting design is not satisfactory (except in the newspapers), for, though our 16,000-tonner has the same broadside fire as the *Dreadnought* (having four, double-gun turrets on the center line), she has 50 per cent less bow fire, and a much lower freeboard—the forcastle and poop decks being, respectively, about 18 and 10 feet above the water-line, whereas the *Dreadnought* is an efficient sea-going battleship, capable of using her guns while steaming at full speed in any sea in which reasonably accurate aiming could be done. The profile of this ship is that of a scout, her forward turret being mounted upon a high forecastle about 35 feet above the water, and the remaining four turrets about 28 feet. All this not to mention the fact that the *Dreadnought* is a better gun-platform, has better protection and has a superiority in speed of two or three knots. (The *Dreadnought's* trial speed was about 21.5 knots).

It would undoubtedly be desirable if we could procure an international agreement that no nation would adopt for its armies a rifle superior to that now used. Similarly, it would be desirable if the displacement of men-of-war could be limited, say, to 20,000

tons. But in the absence of such an agreement, we must keep pace with the increased efficiency in battleships as well as in small-arms, otherwise we cannot reasonably expect to win battles. We have, indeed, no choice in the matter, if we are to remain a world power.

However, from the point of view of naval efficiency, we need have nothing to fear from even a still further increase in the size of our battleships. For example, referring to the supposed fleet of ten 20-knot ships—the short (*S*) fleet—above described, there can be no doubt that the same sum (100 millions) expended for a less number of still larger ships would produce a superior fighting fleet. For the same sum we could doubtless build eight ships each having a broadside fire of ten 12-inch guns, instead of eight, and one knot more speed. Such a fleet would be 1.7 miles long, instead of 2.1 miles, with a concentration of 48 heavy guns per mile to oppose to the 21 per mile of the long (*L*) fleet (3.9 miles) of small vessels—not to mention the increased superiority of its maneuvering qualities, and the superiority of its protection against both gun-fire and torpedoes. One of the great advantages of a large vessel is that the under-water hull can be so designed that the ship cannot be materially damaged by one torpedo.

From the facts and arguments herein presented, as I understand them, I derive the following main conclusions, founded upon what I believe to be the fundamental, elementary principles of gun-fire and tactics:

1. That, in consideration of the fact that the ultimate object of a fleet is that, in the event of war, we may be able to overcome our possible enemies upon the sea, we should so design our battleships that they will at least equal those of our possible enemies in *all* of their fighting qualities—speed, gun-power, height of gun positions, protection, etc.

2. That, subject to the above requirements, it is always desirable to increase the speed a certain reasonable amount.

(Incidentally, it may be remarked that this indicates the advisability of developing maximum speed and minimum coal consumption, by placing all similar vessels in continuous competition in steaming—in much the same manner that we now utilize the competitive principle to develop their maximum gun-power.)

3. That it is always desirable to substitute heavy turret guns,

such as 12-inch, for the equivalent weight of the usual intermediate guns, 6-inch, etc. In other words, that the all-big-gun, one-caliber ship affords the greatest possible capacity of effective hitting.

4. That, in order to simplify fire-control and attain its maximum efficiency, all of the main-battery guns of ships of whatever type should be of the same caliber.

5. That, for similar reasons, all of the torpedo-defense guns should be of the same caliber.

6. That very important tactical advantages are obtained by the concentration of many heavy guns on each large vessel of high speed, and by the consequent intense concentration of fleet gun-fire, due to the compactness of the fleet.

7. That the tactical advantages of size, speed and diminished numbers are of much greater importance than any advantages to be obtained from the increased number of smaller and slower vessels that can be built at the same total cost.

In conclusion, I beg to submit the following considerations that do not bear directly upon the relation of speed, displacement and gun-power to effective gun-fire and tactics.

Captain Mahan assumes that the importance now given to long-range fire with heavy guns implies an indisposition to close, which he assumes would be to the disadvantage of the all-big-gun ships (as opposed to those having numerous intermediate guns), and that history teaches us that this alleged moral attitude is a dangerous one: "that the fleet which has thus placed its dependence on long-range fire has with it assumed the moral tone and temperament associated with the indisposition to close" . . . . and "that the navy which, for any reason, habitually seeks to keeps its enemy at a distance, in order to secure a preliminary advantage, usually fails to achieve more than a defensive success for the occasion, and in the long run finds itself brought to battle at an unexpected moment, under conditions unfavorable to it, both materially and morally."

Doubtless the above is true in all cases where individual ships are materially equal in force and in protection, and, particularly where the inefficiency of the artillery practically precludes effective hitting (that is, a large enough percentage of hits to be decisive) at any but short ranges. However, the conditions of gun-fire have changed fundamentally with the introduction of high-power

guns and, particularly, with our recently acquired knowledge of these guns and their proper use.

Nelson's ships could not do effective hitting at a distance of about one mile, and the shooting of his enemies at the same range was equally as good, or bad. There was practically no possibility of effective marksmanship at long range, because of the rudimentary design of guns, sights, etc. Protection was practically equal, there being no armor. Hitting was dependent upon short range, and superiority of gun-fire depended almost wholly upon superior rapidity of fire. Collingwood said to his men: "If you can get off two broadsides in the first five minutes, you will win." (I quote from memory, and may have the figures wrong, but the above is the gist of his remark).

In order to contrast this with modern methods of gun-fire, I will take the actual case of two actual, similar ships, A and B. At a recent battle practice, while firing under way, at a target 90 by 30 feet, distant not less than 6000 yards, A made about 40 per cent of hits, and B made zero. At the previous test, on a short range, marked by buoys, A made about as good a score as B, thus showing about equal skill in aiming and rapidity of fire on the part of their gun-pointers (whose sole duty is to aim while their officers control the fire). Therefore, if these two ships (or a fleet of A's and a fleet of B's) had met in battle, and A, having sufficient speed (and no moral indisposition to close), had at once steamed in to short range, he would have received practically as many hits as his enemy, and if his rapidity of fire had been somewhat less than B's, even for a short period of time (due, say, to an otherwise insignificant accident to his communciation system), he would have been defeated; whereas, had he taken advantage of the superior skill of his fire-control officers, and remained at long range (as Admiral Togo did), he would not only have won the battle, but would have done so without material damage to his ships or personnel (as in the case of the Japanese), and without danger of defeat through a temporary disability.

If a commander-in-chief knows that his ships are inferior in fire-control, he will of course seek to diminish this inferiority by fighting at short range (as was unsuccessfully attempted by the Russians); but the commander-in-chief of a fleet that is skillful

in fire-control, and who has an indiscriminating disposition to close, appears to me to be out of place as a commander of modern vessels.

Concerning the ships in question—large, all-big-gun, one-caliber ships—I believe it has already been clearly shown that, besides being necessarily superior at long ranges to ordinary battleships (having intermediate guns), they are also superior to them at all ranges, because of the superior protection of the big guns and their gun-crews—not to mention the superior hull protection.

In addition to the superior individual and tactical advantages of large vessels, they also possess the following economical advantages:

1. A fleet of ten 20,000-ton ships, each having a broadside fire of eight 12-inch guns (or 80 in all) would cost about 100 millions.

2. A fleet of 20 smaller vessels, each having a broadside fire of four 12-inch guns (or 80 in all), and the usual intermediate guns, would cost about 120 or 130 millions—though I previously assumed the cost of these fleets to be equal, in order to accentuate the tactical value of large ships.

3. It requires less men to man the main-battery guns of an all-big-gun ship than of a mixed-battery ship. For example, it requires less men to serve the ten 12-inch guns of the *Dreadnought* than the four 12-inch, and sixteen 6-inch guns of the *Missouri.*

4. It will require no more men for the *Dreadnought's* crew than it would for the *Missouri's*—if she had a full complement of men (as measured by European standards), which neither she nor any of our battleships have.

5. The complement of officers of the *Dreadnought* is not as great as should be that of the *Missouri,* or *Louisiana,* because the former requires but one fire-control party, while the latter ships require respectively two and three parties, as well as more officers to command the guns.

6. Therefore, assuming 800 men and 20 combatant officers in each ship, it will require 8000 men and 200 officers for 10 all-big-gun ships, and about 16,000 men and 400 officers for the fleet of small vessels having the same broadside fire.

(Incidentally, it may be remarked that if the money we have expended for the ships recently commissioned and now being completed, had been put into 20,000-ton, all-big-gun ships, we

would not now be embarrassed for either men or officers to man them—and would have a stronger fleet.)

7. It will cost nearly twice as much to dock the 20 small vessels as the 10 large ones—and the latter fleet can be docked in one-half the time, which is a great advantage in time of war.

(Captain Mahan notes that the absence of a big ship—for docking, coaling, repairing, etc.—reduces the strength of its fleet more than the absence of a small one, but he neglects to note that with twice as many ships in a fleet there will be twice as many absentees in a given time.)

8. From the above it is clear that the cost of maintaining a fleet of small vessels, having the same broadside fire as a fleet of large vessels (of double the individual broadside fire), will be nearly twice as much as that of a fleet of large vessels of about the same total gun-power.

9. I understand that the cost of maintaining a battleship is over one million dollars per year. Therefore the yearly maintenance of the fleet of 10 large vessels would cost about 10 million dollars less than that of the 20 smaller ones.

10. The final conclusion is that, for the sum that it would cost to maintain 20 small battleships, we could maintain a fleet of 10 large ones, that would be greatly superior in tactical qualities, effective hitting capacity, speed, protection, and inherent ability, to concentrate its gun-fire, and have a sufficient sum left over to build one 20,000-ton battleship each year—not to mention needing fewer officers and men to handle the more efficient fleet.

By the above examination, I have attempted to show that Captain Mahan's conclusions are probably in error, only because they are, in my opinion, founded largely upon mistaken facts (as to the battle of the Sea of Japan), mistaken principles of gun-fire, and upon an apparent failure to consider the inherent and very important tactical qualities of large vessels. In my analysis, I have considered only those alleged errors by which I believe that Captain Mahan was mainly influenced, omitting, for the sake of brevity, a number of minor ones that bear upon, but are not essential to, his conclusions.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

CHRISTIAN ETHICS AN ELEMENT OF MILITARY EDUCATION.[1]

By REAR-ADMIRAL S. B. LUCE, U. S. Navy.

Religion and war are the two great central facts of history. Around these two points cluster pretty much all that is worth knowing of the past. Religion gave birth to education; war led the way to civilization. The ritual of the ancient pagan worship necessitated an educated priesthood, and the temples of worship were monuments to the genius and skill of the times. During many ages man's highest faculties were developed in doing homage to that Being whose presence was everywhere felt, whose wisdom and justice in ordering the affairs of this world were everywhere acknowledged. The fragments of those masterpieces of pure taste and unrivaled architectural skill which still remain to us are eloquent tributes to the piety of the warlike races that reared them. All that is beautiful and chaste in music and painting, in poetry and the drama, we owe primarily to religion.

Next in importance to the priesthood of the ancient civilization came the military caste. War was the great school wherein men of intellect could cultivate their genius, or gratify their ambition. The training of the young was mainly directed towards preparing them for the field. With this training there was inculcated such a pious regard for the gods of their fathers as to develop the highest virtues in the sons; hence a deference to the guardian powers of their country, and an open, fearless profession of their belief, are found to be characteristics common to all the great military leaders of antiquity.

The hardest fighters, whose deeds are recorded in the Iliad, are those who are most fervent in their appeals to the gods. Achilles,

[1] Reprinted from the "United Service" of January, 1883.

in an earnest prayer, invokes the aid of Jove in behalf of his friend Patroclus, and the great Hector, all stained and spent "with long laborious fight," rejecting the proffered cup because it "dulls the noble mind," bids Hecuba repair to the virgin's fane, and with prayers and oblations avert the city's doom. These were the typical heroes of the time.

The Persians taught their children virtue, says Montaigne, as other nations taught letters. After young Cyrus, subsequently the greatest captain of his time, had completed his military education under the ablest masters, Cambyses instructed him in military ethics. In a short time, Xenophon tells us, he taught him more, and what was of more importance to him as a military commander, than all his celebrated teachers had done. He concludes by saying, "Above all he, (a military commander,) must have recourse to the protection of the gods, from whom alone we receive all our wisdom and all our success." Cyrus put in practice the excellent lessons he had received, never failing to invoke the gods to be favorable to his enterprises, and beginning and ending all his battles with prayer. "For it is observable," says the historian, "that on such occasions *those that fear the Deity most are the least afraid of men.*"

The Greeks were the first to develop the science of secular education, in which mental and physical culture had an equal share. To these Socrates added logic, moral science, and the cultivation of the heart.

It was with religious ceremonies that the Athenian youth, on entering his nineteenth year, was admitted to the civic list. Armed with a shield and a spear he was escorted to a temple devoted to worship, and there took a solemn oath of loyal service to his country and the gods. "I will do battle," he vowed, "for the common weal and for the religion of my fathers." For the Athenian government laid special stress upon religious influences in education. It insisted that the young men should be trained to reverence the guardian powers of the State, in the hope that they would grow up to orderly and pious manhood. Hence, we find that no Greek army marched to battle without first offering prayers to the Deity; no Greek fleet undertook a military movement without supplications for success.

Xenophon, whose remarkable retreat with the "Ten Thousand" through an enemy's country is still regarded as one of the most

brilliant and instructive passages in military history, said it was only "reasonable to believe that the Divinity would guide and protect those who adored him with the purest affection, who invoked him with the greatest constancy, and consulted him with the most sincerity." By way of enforcing his arguments he gives an illustration of the insufficiency of a purely military school by proving that a graduate of one of them had acquired nothing but self-conceit. He then proceeds, in the person of Socrates, to give some lessons in military ethics, "without which no man, however skilled in war, can become truly great." Xenophon regarded religion from a strictly military and practical point of view. "If any one wonders," says he, "that I insist so much here upon the necessity of not forming any enterprise without first endeavoring to render the Divinity favorable, let him reflect that there are in war a thousand unforeseen and hazardous conjunctures wherein generals, vigilant to take advantages and lay ambuscades for each other, from the uncertainty of the enemy's motions, can take no other counsel than that of the gods. Nothing is doubtful or obscure with them. They unfold the future to whomsoever they please. Now we may presume that the gods are more inclined to those who not only invoke their aid on urgent occasions, but who at all times, and when no dangers threaten, render them all the homage and adoration of which they are capable."

The education of the Spartan youth was calculated, in a pre-eminent degree, to produce the highest type of soldier. While the physical training was thorough, those higher qualities, a lofty sense of honor, an exalted patriotism, dauntless courage, perfect self-control, and a sincere reverence for the gods, were carefully cultivated. Plutarch tells us that the Spartans marched to battle as if God were present and fought for them; and this practical piety, and the true courage it imparted, were attributed by Cicero less to their natural disposition than to their excellent education. Of all the people of their times, the Spartans best understood military ethics, or the practice of the military virtues. There is a striking similarity between the training of Spartan youths and those of Japan.

Alexander the Great adopted the godlike Achilles as his model. The theology of Homer was his religion; the Iliad his Bible. He had been carefully educated by Aristotle, who was a pupil of Plato, who was a pupil of Socrates himself. Aristotle's scheme

of education embraced the development of the moral, intellectual, and physical natures with a view to the rounding out of the humanly perfect man. Such, according to Arrian, was Alexander. "In body he was most handsome, most indefatigable, most active; in mind most manly . . . and most religious; in sensual pleasures most temperate."

In the warlike republic of Carthage devotion to the Deity was agreeable to the genius of the people. Its generals regarded it as a solemn duty to begin and end all military expeditions with the worship of the gods. On the eve of setting out on his great campaign Hannibal repaired to Cadiz, and there, in the temple of the supreme god of Tyre, offered up his prayers for the success of his enterprise. He regarded himself as the chosen instrument of his country's gods to destroy their enemies. With an undivided heart, as we are told, and with an entire resignation of all personal and domestic enjoyments forever, he went forth at the early age of twenty-seven to fulfil his high mission.

Have you not observed says Socrates, in his dialogue with the irreverent Aristodemus, that the wisest nations and the most stable governments are those which are the most religious? And, according to Cicero, it was the universal acquiescence in the wisdom and justice of the Almighty that raised the Romans above all other nations. In the Roman, indeed, the warlike and religious elements were singularly blended. In her early days of purer faith the simple Roman husbandman lived and died like his Sabine ancestors in the fear of the gods. He believed there was something in the universe higher and better than himself; that to these powers good deeds and an honest life were pleasing, evil deeds and bad faith hateful. "There can be little doubt," says Liddell with emphasis, "that the simple morality of the times, maintained by habitual deference to authority, was confirmed by the higher sanction of religion." The attachment of the Roman troops to their standards, says Gibbon, was inspired by the united influence of religion and honor. "It was *this* that rendered the legions of the republic invincible." Carlyle has particularly noticed this trait of the Roman character. Ferguson, he observes, "points out the profoundly religious character of the Roman people, notwithstanding the wildness and ferocity of their nature. They believed that Jupiter was lord of the universe, and that he had appointed the Romans to become the chief of men, provided

they followed his commands to brave all difficulties, to stand up with an invincible front, to be ready to do and to die, and also to have the same sacred regard to veracity, to promise, to integrity, and all the virtues that surround that noblest quality of man,—Courage,—to which they gave the name of *virtue,—manhood,* as the one thing ennobling for a man." All history goes to show that the Romans of the republic were more pure in morals, more honest, more self-denying than their neighbors; and a clear-sighted Greek, says Liddell, accounts for the difference by their stronger sense of the obligations of religion. It was the very first act of Fabius, on being elected dictator, just after the great disaster to the Roman arms at Thrasymenus, to attend at the celebration of the most sacred rites known to his religion. Having completed these, he turned his attention to the state of war. A strong religious bias was a notable characteristic of Scipio (Africanus), who finally delivered his country from the fear of her enemies. Cæsar's final summons came not in disease, nor old age, nor in the excitement of battle; but in the prime of life, and in the enjoyment of health and domestic happiness. Nothing in the history of this great captain so clearly demonstrates the firm support he derived from his religious belief as his bearing during the last hours of his eventful life. He was not disturbed by the admonition of the gods, conveyed, as he believed, through Calphurnia's dream. "Be it so," said he. "If I am to die to-morrow, that is what I am to do to-morrow; it will not be *then* because I am willing it should be then, nor shall I escape it because I am unwilling; it is in the gods *when,* but in myself *how* I shall die. If Calphurnia's dreams are from the gods, their admonition is not to prepare me to escape from their decree, but to meet it. I have lived to a fullness of days and of glory. Cæsar is prepared to die." From the simplicity and purity of primitive belief, and from virtuous industry, Rome pursued her successful career to power and wealth, thence to luxury and indolence, which brought political corruption and impatience of discipline on the part of the people. With loss of virtue came the loss of liberty and everything worth having, till finally the people relapsed into their original barbarism. Such is the law governing the rise and fall of nations.

The early history of that race which first threatened and finally overcame Rome is not less instructive. Speaking of the countries

of Northern Europe, we are told that the education of the Teutonic nations, their laws, morality, and religion, all concurred to make war their ruling passion. Their laws knew only the military virtues; no crime but cowardice. Religion, by annexing eternal happiness to the former, gave the highest degree of activity to their ardor for war. Their indomitable courage was stimulated by the promised joys of Valhalla for those who fell in battle. Nor was their passion for a wild, adventurous life abated by their conversion to Christianity. As pagans, they had been most zealous sectaries of Thor, the god of battles. As Christians, they became the enthusiastic devotees of Michael, the archangel, whom they were taught to believe was equally as renowned in demoniacal warfare as the Scandinavian deity. As the Norsemen were incited to deeds of heroism by visions of the Valkyries, so the Mohammedans saw, in fancy, the dark-eyed Houris ready to welcome to an eternity of bliss those who died fighting for Allah and his prophet.

So firm was the belief among certain nations that the Deity assisted those who were enlisted in a good cause, that in the Hebrew, Arabic, Syric, and Chaldeac languages words which originally signified *justice, innocence,* or *uprightness,* came to express likewise the idea of *victory;* and words whose usual meaning was *injustice* or *wickedness* also meant *defeat* or *overthrow.* The same may be said in respect to words which signify *help* or *aid,* inasmuch as the nation which conquered received aid from God, and God was its helper.

In the early history of the Jews we find many instances of the direct influence of religion upon the issue of battles and the results of campaigns. They fought in the name of the Lord of Hosts. Their battle-cry was, "The sword of the Lord and of Gideon." "Thou comest to me with a sword, with a spear and with a shield," cried the stripling warrior of Israel to the giant Philistine; "but I come to thee in the name of the Lord of Hosts, the God of the armies of Israel, whom thou hast defied." Though not a military race, their sacred books contained, besides accounts of battles, many allusions to military affairs. Ensigns raised on high, and signal-fires at night, are frequently mentioned as the signs of war, while opposing hosts are marshaled by the sound of the trumpet. These warlike practices were so common that they finally came to be used as figures of speech;

and, by a natural association of ideas, the sphere of operations was transferred from the physical to the moral world. Here the contest was carried on between the spirit of good and the spirit of evil.

When all that was good and pure in the ancient faiths became crystallized under the Christian dispensation, the metaphor was kept up, Christian writers representing man's sojourn on earth as the Battle of Life, where the conflict rages in his own heart. To gain this battle and to win his inheritance to a life of eternal peace is the object of the Christian soldier. The battle begins in early youth, and the same discipline which enables the young warrior to subdue his own evil nature and obtain command over himself, enables him, in maturer years, to command others, and to overcome the enemies of his country. Such, in the main, is the Christian and modern theory of virtue. It does not differ materially from that which obtained in the meridian of the ancient civilization. For religion is not based on outward forms and ceremonials. The practices of divination, the consulting of oracles, or reading the future by the entrails of beasts or the flight of birds, were never made essential points of religious belief. Far less have the fundamental truths of religion to do with the hideous crimes and gross immoralities that have, in almost every age been perpetrated in religion's sacred name.

The various systems of ancient faiths had their rise, development, and decay according to natural laws, each system being suited to the times and the genius of the people, and all founded on the two great fundamental truths,—the existence of a Deity and of a future life. It is these two truths, indeed, which underlie all systems of religious beliefs: not only those of to-day, but even those of the tribes of the remote East, whence history and civilization had its genesis, as well as those of the peoples of the Western Hemisphere, which, like meteors of unknown origin, have appeared for a time only to fade away, the sole repositories of their own mysterious history. Even the denizens of the North American forest believe in a Great Spirit, and that it is in the Happy Hunting-Grounds of a better world that they will still pursue the chase.[2]

[2] The Vikings of the stormy Scandinavian shores alike with the dusky warriors on the quiet banks of the Mississippi buried their dead with their arms and accoutrements, and fully equipped for the life, perchance the con-

Such universal concurrence of belief in the great truths of what may be called natural religion can proceed only from a necessity of man's nature, an unerring instinct which prompts him in his needs to look for help from something higher and better than himself, and whose beneficent care will extend beyond this life. It can readily be imagined how princes and great generals and admirals having vast armies or numerous fleets, perhaps the liberties of their country, or the destiny of nations in their keeping, would, when impressed with a sense of their responsibilities, turn instinctively for help to a source of power above and beyond this world. The great Atrides termed that power,

> "The resistless Lord of all,
> At whose command whole empires rise and fall.
> He shakes the feeble props of human trust,
> And towns and armies humbles to the dust."

So sang the blind poet of Chios over twenty-five centuries ago.

To confound the religious belief of any age with superstition is to misapprehend the very highest attribute of human nature. "*The kingdom of God is within you,*" said our Lord, and we do but repeat the words of the pagan Socrates in saying it is the highest duty of the educator to develop and bring it out.

Under the Christian dispensation a purer and better system of ethics—far better and purer than any that had preceded it—was founded on that doctrine whose central idea was Love: love not only for that Deity man's own deeper nature had ever yearned for, but it included also the Divine law of love for one another.

With the introduction of Christian ethics came a modification of ideas in regard to the virtues. The word Duty assumed a wider and deeper signification, and Honor, one of the cardinal virtues in military ethics, once synonymous with courage, now associated itself with the highest and noblest aspirations of man.

"Honor," as well expressed by an eminent English divine, "will discover itself by a mind superior to fear, to selfish interest, and corruption, by an ardent love to the Supreme Being and by a principle of uniform rectitude. It will make us neither afraid

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flicts, of another world. And mounds in various parts of America, have, after centuries of silence, opened their dumb lips to reveal this one secret of the belief—a life after death—of a people whose very existence is otherwise shrouded in impenetrable mystery.

nor ashamed to discharge our duty as it relates both to God and to man. It will influence us to be magnanimous without being proud, humble without being mean, just without being harsh, simple in our manners, but manly in our feelings. Honor thus formed by religion, or the love of God, is more dependent and more complete than what can be acquired by any other means." It is wonderful to observe how the characters of many of the military and naval leaders of Greece and Rome in their palmy days illustrate even this definition of honor. The moral courage of Socrates in defending from the popular wrath of the Athenians the six admirals who had fought at Arginusæ; Alexander's chivalric deportment towards the beautiful consort of the unfortunate Darius; Regulus leaving Rome to redeem his pledge to Carthage, are all in their several aspects, fine examples of a high sense of honor. In pagan Rome the temple erected by Marcellus to Honor could be reached only by passing through the temple he had dedicated to Virtue.

If the fusion of the religious with the military element produced the highest type of pagan soldier, the result of the combination was even more marked with the Christian. The spirit of Chivalry was born of the tyranny and corruption, the terrorism and confusion of the Dark Ages. It was nurtured by the church for the maintenance of religion and good order. As the Athenian youth was admitted to the civic list, and assumed his arms with religious ceremony, and the delivery of the virile robe to the young Roman was made an occasion of public solemnity, so the young novice was admitted to the order of knighthood under the auspices of the Holy Catholic Church. He solemnly vowed, his hands on the missal, "to undertake nothing without having first performed his religious obligations; to spare neither blood nor life in defense of his religion; to give aid to all widows and orphans; to undertake no war without just cause; to favor no injustice, but to protect the innocent and oppressed; to be humble in all things; to seek the welfare of those placed under him; never to violate the rights of his sovereign; and to live irreprehensibly before God and man." Self-denial was his boast, honor his sole reward. He was simple in attire, austere in morals, humble after victory, steadfast under misfortune. Chivalry more than any other institution, save the mother-church alone, aided in the civilization of Europe, and having fulfilled its high mission

passed away, leaving as a heritage, common to all aspirants of military fame, the names of Du Guesclin, of Bayard, and of Sidney. To possess these virtues is to be a gentleman.

The exaltation of the military spirit by the fervor of religion reached its climax in England under the Commonwealth. The stern morality and religious zeal which pervaded all ranks distinguished the armies of Cromwell from all others. In his camp no oath was heard, no drunkenness or gambling seen. The property of a citizen and the honor of woman were held sacred. The "praying Puritan" was invincible. However surrounded by difficulties or outnumbered in force, they were invariably victorious. They routed the most renowned battalions of Europe, and carried positions deemed impregnable by the most skilful engineers of France. "They fought so well," it was said, "because they prayed so well." It was this spirit that made the armies and fleets of Cromwell the terror of the world.

It would be an easy task to illustrate, by the examples of many Christian soldiers and sailors, the truth of Xenophon's proposition, that ethics is essential to a thorough course of military instruction. But the argument would be strengthened by illustrations drawn from those masters of the art of war who have not been distinguished for their moral qualities. Turenne, for example, had, from his youth up, says Cardinal de Retz, all the good qualities, and very early he had acquired all the great ones. It is but natural in such a character to find only what is truly good and noble. But with his distinguished rival, the great Condé, it was not so. Though he died in the faith, yet during the greater part of his life Condé was an unbeliever. But he had been carefully educated under his father's eye, and early trained in those habits of self-command which fitted him for the command of others. He possessed certain military virtues in an eminent degree, though they were not founded in Christian ethics.

Marlborough, in his youth, was a profligate. Macaulay does not hesitate to stigmatize him as a villain and a traitor; and yet his tenacious adherence to the Anglican Church was the one point that would not yield to his sordid love of gold. On the night preceding the battle of Blenheim the arbiter of the destiny of Europe received the sacred rites of the Holy Communion at the hands of his chaplain; and after the battle he declared that he had prayed that day more than all the chaplains of his army.

With Frederick the Great it was far different. Religious feelings could hardly be predicated of one who claimed the friendship of Voltaire. But in the sad years of his early life his bad father had subjected him to a discipline which, in its Spartan rigor, prepared him for the exactions of a military life. A stern sense of duty became his religion. Duty was to him the Law and the Prophets, as Carlyle had expressed it.

In Wellington the Christian and military virtues were admirably adjusted; but there are no terms sufficiently strong, with some writers, for the reprobation of Napoleon. But when Paris, drunk with the blood of her own citizens, had formally declared there was no God, and had abolished the Christian religion, it was one of his first acts, on obtaining control of the city, to open the churches and restore religious worship as a political necessity.[1] "Can you disbelieve in God?" he said to his physician during the last few and painful days of his life; "everything proclaims His existence, and the greatest minds have thought so." In a conversation with Montholon and a few others just before his death, on the subject of a future life, "As for me," he said, "I shall behold my brave companions in arms in the Elysian Fields. Yes, Kleber, Dessaix, Bessieres, Duroc, Ney, Murat, Masséna, Berthier, all will come to greet me. . . . We will discourse of our wars with the Scipios, the Hannibals, the Cæsars, and the Fredericks." To the Abbe Vignali: "I believe in God; I am of the religion of my fathers. . . . I was born in the Catholic religion; I wish to fulfil the duties which it imposes, and to receive the succor which it administers." And, finally, according to his own testament, he died in the apostolic Roman religion in which he was born.

It was only to be expected of the exalted character of Collingwood that his conduct should be exemplary in all the relations of life; but Nelson openly violated the most sacred of social obligations. And yet Nelson was a firm believer in the doctrines of Christianity. With singular inconsistency he wrote, just before his last battle, a prayer breathing the very spirit of true piety,

[1] "The measure for discarding the heathen ritual and re-opening the churches for Christian worship was due to Napoleon alone. In opposing the philosophic prejudices of his colleagues he made no pretense of being himself a believer in Christianity, but stood on the necessity of providing the people with the regular means of worship wherever it is meant to have a state of tranquility."—*Lockhart.*

and with the self-same pen placed on record the evidence of his own dark crime. And so we might continue to examine the lives of all the great masters of the art of war only to find that in nearly every case there has been either a solid foundation of character in deep religious convictions, or that the spirit has been chastened by early discipline, almost invariably in the stern school of war. Nor is this truth limited to any age or religion, as we have endeavored to show. The "Unknown God" ignorantly worshipped by a pagan world, was, in the fullness of time marvelously revealed to man. It is the same God throughout all time, and space.

The questions we have now to consider are how far the Government of the United States provides education for the young, and how much does the element of ethics enter into its school system? Before answering these questions let us first examine the popular fallacy that "there is no God in the Constitution."

The Constitution of the United States is based upon the Christian religion. Our English ancestors brought over with them to this country their dearest rights to life, liberty, and property, as recognized by the common law of England. But the common law embraced the Christian religion; hence the Constitution, in accepting the common law, accepted also the Christian religion. This is true not only of the Constitution of the United States, but of every State Constitution; and wherever the English common law is recognized by the people the Christian religion is recognized with it.[4]

The Fathers of the Republic were, many of them, eminently pious men. In one of the stormy discussions which finally led to the formation of the government, Franklin made use of the following language: "In this situation of the Assembly, groping

[4] The common law has been assumed by the courts of justice or declared by statute (so far as it is applicable to our situation and government) as the law of the land in every State. It was imported by our colonial ancestors, as far as it was applicable, and was sanctioned by royal charters and colonial statutes. "The Congress of 1774 claimed to be entitled to the benefit not only of the common law of England, but of such of the English statutes as existed at the time of the colonization and found to be applicable."—*Kent.* One of the first articles of Magna Charter, which was made part of the common law, secured the liberties of the church.

"In suits at common law . . . . no fact tried by a jury shall be otherwise re-examined, in any court of the United States, than according to the rules of the common law." [Constitution of the United States of America.]

as it were in the dark to find political truth, and scarce able to distinguish it when presented to us, how has it happened, sir, that we have not hitherto once thought of humbly applying to the Father of lights to illuminate our understandings? In the beginning of the contest with Great Britain, when we were sensible of our danger, we had daily prayer in this room for the Divine protection. Our prayers, sir, were heard and they were graciously answered. . . . Have we now forgotten that powerful friend? . . . I have lived, sir, a long time, and the longer I live the more convincing proofs I see of this truth, *that God governs in the affairs of men.* . . . I therefore beg leave to move that henceforth prayers imploring the assistance of Heaven, and its blessings on our deliberations, be held in this Assembly every morning before we proceed to business." The motion was not carried at that time, it is true, but for years past the deliberations of our National Legislature have been opened with prayer. Furthermore, the Chief Magistrate appoints, annually, a day of thanksgiving, when the people are invited to suspend their usual avocations and turn their hearts in grateful praise to the Giver of all good, for the manifold blessings showered upon this favored land. The Supreme Court of the United States, in its implicit faith in the sanctity of an oath taken in the name of God, recognizes the Christian religion. In short, the very spirit and genius of our institutions are rooted and grounded in Christianity.

Another grave error is to suppose that in securing to every American citizen perfect freedom of religious belief, the Constitution intended to grant immunity from religious duties in general. On the contrary, it was intended especially to guarantee the enjoyment of some particular form of religion agreeably to the choice of the individual. A law framed under the Constitution provides for the appointment of chaplains. Another law declares that the commanding officer of a ship having a chaplain on board shall cause divine service to be performed on Sunday; and the law in its majesty "*earnestly recommends to all officers, seamen, and others in the naval service diligently to attend at every performance of the worship of Almighty God.*"[5] In the same spirit the Navy Regulations require that "Sunday shall be observed on board of all ships, and at all naval stations, in an orderly manner: all labor shall be reduced to the requirements

[5] Articles for the government of the Navy of the United States.

of necessary duty; and the religious tendencies of officers and enlisted men shall be recognized and encouraged." In the Articles of War governing the army, "all officers and soldiers are recommended diligently to attend divine service," and in both the military and naval codes the law prescribes a penalty for any "irreverent or unbecoming behavior during divine service."

The views of Washington and of Lincoln on this subject are strikingly set forth in the following:

GENERAL ORDER RESPECTING THE OBSERVANCE OF THE SABBATH DAY IN THE ARMY AND NAVY.

EXECUTIVE MANSION,

WASHINGTON, November 15, 1862.

The President, Commander-in-Chief of the Army and Navy, desires and enjoins the orderly observance of the Sabbath by the officers and men in the military and naval service. The importance for man and beast of the prescribed weekly rest, the sacred rights of Christian soldiers and sailors, a becoming deference to the best sentiments of a Christian people, and a due regard for the Divine will, demand that Sunday labor in the Army and Navy be reduced to the measure of strict necessity.

The discipline and character of the national forces should not suffer, nor the cause they defend be imperiled, by the profanation of the day or name of the Most High. "At this time of public distress," adopting the words of Washington in 1776, "men may find enough to do in the service of God and their country, without abandoning themselves to vice and immorality." The first General Order issued by the Father of his Country after the Declaration of Independence indicates the spirit in which our institutions were founded and should ever be defended: "The General hopes and trusts that every officer and man will endeavor to live and act as becomes a Christian soldier defending the dearest rights and liberties of his country."

ABRAHAM LINCOLN.

It is difficult to see how a liberal form of government could go further towards encouraging religious observances on the part of those in its own immediate service.

The Government of the United States has wisely left to each State the working out of its own system of popular education. From the proceeds arising from the sale of public lands, however, it has provided a fund to aid in the support of the common schools in the several States, and to found colleges for the promotion of scientific agriculture and the mechanic arts; it has endowed universities, and a Bureau of Education has been attached to one of the Executive Departments—the Interior—for the collection and dissemination of information relative to edu-

cational subjects. Beyond the encouragement thus given to the cause of education in general throughout the country, the government abstains from all interference with our public schools. But while every State has its own common-school system, each varying from the other more or less in matters of detail, there are yet certain vital points which are common to all. Happily, the very theory on which our entire educational system is based admits the necessity of instructing the young in Christian ethics. In a recent publication giving what may be regarded as an official exposition of our theory of popular education, it is remarked that "in America (meaning the United States) the peculiarities of civil society and the political organization draw the child out of the influence of family nurture earlier than is common in other countries. The frequent separation of the younger branches of the family from the old stock renders family influence less powerful in moulding the character. The consequence of this is an increased importance of the school in an ethical point of view. In order to compensate for lack of family nurture, the school is obliged to lay more stress upon discipline, and to make far more prominent the moral phase of education. It is obliged to train the pupil into habits of prompt obedience to his teachers, and the practice of self-control in its various forms, in order that he may be prepared for a life wherein there is little police-restraint on the part of the constituted authorities. . . . In the commercial cities the tendency is in the direction of punishment founded on a sense of honor."[*]

These views are fully supported by the testimony of President Porter of Yale. "Whatever can be done," he remarks, "to awaken and direct the kindling zeal of those youths who are ashamed to be called 'college boys,' to vary the burdens and relieve the tedium of their life, whatever can be done to confirm their health, to refine their manners, to awaken their self-respect, and to stimulate and guide their faith in Duty, in Immortality, and in God, not only comes fairly within the scope of the College, but becomes a duty which rests upon its guardians. Not a few experiments in college discipline and management are announced

[*] "A Statement of the Theory of Education in the United States of America, as approved by many leading Educators." Issued in 1874 by the Commissioner of Education, and with the approval of the Secretary of the Interior.

in various quarters which promise to relieve students, and especially younger students, from the sense of constraint and the necessity of constant accountability to monitors and teachers. The announcement of every new device would be hailed by all teachers who are tired of marks and monitors, were it not true that the longer and more various is the experience of the veteran teacher, the more tenacious does he become of the conviction that to *have learned to meet a duty promptly, thoroughly, and without excuse or complaint, is one of the prime conditions of a successful student* and public life, and that to the scholar and professional man above all, habits of this sort are of inestimable value. If such habits are to be formed they must in some way be effectively enforced. If they are self-enforced, so much the better; but in such a case the monitor awakens no reaction and needs no apologist. So long as bankers' and merchants' clerks and employes of every sort must keep their hours, and these hours are often prolonged into tedious confinement, it strikes us as altogether unreasonable that college youths should complain of any peculiar hardship, or that their guardians should second their sighs. On the other hand, it should not be forgotten that their teachers are equally bound to be mindful that their pupils are mercurial, fickle, and oftentimes forgetful of the most serious truths and obligations, and consequently demand the exercise of unwearied patience and good temper. *The ease with which, in public schools and colleges, the plainest axioms of manners and morals are disregarded, and the accepted axioms of courtesy and truth are openly violated by specious casuistry, is one of the wonders of college life.*"[1]

By many, these views will now be considered as somewhat antiquated. In the higher schools, both in England and in America, direct moral teaching has been, by common consent, discontinued, as a part of the ordinary class work. But practices which prevail at the great seats of learning do not necessarily apply to our national academies. The latter form a distinct class by themselves, and must be governed by rules specially adapted to their purely technical character.

Under the constitutional provisions imposing upon Congress the duty of providing for the "common defense of the United States," and "to raise and support armies and to provide and

[1] Report of the President of Yale College, October 31, 1881.

maintain a navy," a military and naval academy have been established. The pupils of these academies, being the nominees of members of Congress, may be said to be fair representatives of the several grades of society in the various parts of the country, and in that way to embrace a greater range of character and of social antecedents than can be found at our leading colleges. The remarks in regard to the students of Yale, already quoted, will therefore apply, it is not unreasonable to suppose, to the junior classes of cadets at the national academies. We specify the junior classes, and hasten to add that the moral atmosphere and the strict discipline of these institutions is so wholesome that the tone of the classes rapidly improves as they advance, till the first-class man comes to be looked upon as a "man of honor," according to the generally accepted code of honor, and one who may be depended upon for the faithful performance of his duty. This we readily and gladly admit.[8] But, speaking in more general terms, there is no doubt that, while numbers of youths leave their homes for the national academies well equipped both mentally and morally for the battle of life, there are yet others who are not so fortunate. Some have not been blessed with a parent's care; the parents of others may have held uncertain views in regard to religion; the parents of some may have been materialists. There are, indeed, religious people who, with a curious obliquity of moral vision, prefer to let their children grow up totally free from religious bias in order that they may be at liberty, on attaining the years of discretion, to form their own opinions on the subject. Others, again, contend that their children are not Christians till they "get religion" through the exhortations of an evangelist. We find some important testimony on this very point in the annual report of the president of Harvard College for the college year of 1880-81.

From the evidence of "many leading educators" in the United States, we are led to the conclusion that of all the youths who annually find their way to our national academies, those of high moral culture are not in the majority. It becomes an interesting question, then, how far is any deficiency in this respect supplied by the Government? The Government of the United States having

[8] This was true when written twenty-three years ago. Recent developments at the Naval Academy, 1906, unfortunately demand a modification of this admission.

accepted the cares and responsibilities of guardianship over a given number of youths, how far does it fulfil its sacred obligations by providing for their moral and religious training? To state the case differently, how far does the Government sympathize with, and give encouragement to, those of its wards who bring with them from home strong moral and religious tendencies? And how far does it exercise a wise parental authority in bringing to a knowledge of moral science those who are ignorant of its principles? If the curriculum of an academy is any evidence, the Government schools furnish no instruction whatever in morals. To each academy a chaplain is attached, and a sort of perfunctory service held in the chapel every Sunday forenoon, an enforced attendance not being regarded with favor by the majority of the cadets. The reading of the church service and a sermon by the chaplain constitutes the entire course of religious instruction seriously undertaken. There is, however, a volunteer Sunday evening service, attendance at which is wholly dependent upon the persuasive powers of the chaplain, and the attractions of a volunteer choir; and it sometimes happens that a few of the cadets associate together for religious exercises. We may go further, and say that there is something in the personal contact with a certain class of instructors which is in itself refining and elevating; and in the *campus* of every Anglo-Saxon school there is an unwritten code of ethics which every lad, who would stand well with his fellows, must conform to. But all of these, with the single exception of the Sunday morning church service, are adventitious circumstances and cannot be counted, valuable as they undoubtedly are in their way, as part of an organized plan of including ethics in a course of military education. It cannot be said, therefore, that any effort is made at either academy to lead the students along the lines which tend to the formation of character.

The Articles of War declare that all commanding officers are required to show in themselves a good example of Virtue, Honor, Patriotism, and Subordination. But where is the young officer, preparing for the responsibilities of command, to learn these things? We can find in the list of subjects taught at these academies no study which inculcates the practice of virtue, none in which a correct standard of honor is given; no instruction as to the nature and duties of patriotism, in the obligations of duty or the necessity of subordination.

The very first commission issued to the young officer states on its face that it has been given by the President of the United States, by and with the advice and consent of the Senate, in token of their "special confidence in his *Patriotism, Valor, Fidelity,* and *Abilities.*" How is this confidence to be justified if the recipient has never been instructed as to what constitutes patriotism, or taught in what true valor consists? how his fidelity to his government is to be manifested, or how far he is bound to keep up the cultivation of his abilities? Has the government a right to place such confidence in the possession of virtues it takes no pains to inculcate? At this one point, unfortunately, the Government stops short. Obviously, it is the plain duty of every officer, save only in those rare cases of conscientious scruples, to attend divine service whenever held at any army post or on board ship. The obligation to do so is just as imperative as it is to take a tour of military duty, and the neglect on the part of the officer to conform to the solemn injunction of the government, as expressed by the law, is evidence of defective training. The confusion of ideas which betrays the officer into this disregard of the obligations imposed upon him will betray him into the neglect, or the imperfect performance, of any duty that may not be to his taste. In short, he is ignorant of the requirements of Duty.

If the undergraduate reasons on the subject of neglect of duty at all, he reasons incorrectly. And it is because there is so much incorrect reasoning on the subject of Duty and Honor, that with the study of Moral Philosophy a course of Logic is essential to a complete course of military instruction. "Logic," observes one of the most profound thinkers of modern days, "is the intellectual complement of mathematics and physics, and there is no part of the intellectual education which is of greater value, or whose place can so ill be supplied by anything else. Its function is not so much to teach us to go right, as to keep us from going wrong. . . . . It is the great disperser of hazy and confused thinking; it clears up the fogs which hide us from our own ignorance and make us believe that we understand a subject when we do not. It makes our opinions consistent with themselves and with one another, and forces us to think clearly, even if it cannot make us think correctly."

Again: "If you take an average human mind before the objects it has chosen in life have given it a turn in any bad direction,

you will generally find it desiring what is good, right, and for the benefit of all; and if that season is properly used to impart the knowledge and give the training which shall render rectitude of judgment more habitual than sophistry, a serious barrier will have been erected against the inroads of selfishness and falsehood. It is a very imperfect education which trains the intelligence only but not the will. No one can dispense with an education directed expressly to the moral as well as to the intellectual part of his being. Such education, as far as it is direct, is either moral or religious; and these may either be treated as distinct or as different aspects of the same thing. Moral and religious education consists in training the feelings and the daily habits." The deduction, we repeat, is inevitable that the study of that science which includes a knowledge of ourselves and of our duties in this life, coupled with due instruction in the methods of correct reasoning, are essential parts of a military training. In 1886 a special course of instruction in physiology and hygiene was established at the Naval Academy, in accordance with an Act of Congress, approved May 20 of that year. Recent events at the Academy (1906), show that Moral Science and Logic should have been included.

President Porter, to quote that eminent authority once more, remarked of Yale, that "it will not be questioned that the guardians and instructors of an institution which is avowedly Christian should be held to an exacting responsibility for the influences they exert, or fail to exert, in forming and strengthening right moral and religious principles. . . . Our history in the past and our promises for the future all commit us to a characteristic and decided Christian culture."

If such is the loving care of this Alma Mater for the spiritual welfare of those who go out from her bosom never to return, how much more tenderly should the Great Republic nurture those whose lives are to be devoted to her service and to the defense of her honor!

"Beware of the men who contend for honor rather than for gold," said an Eastern noble to the Great King, when, twenty-three centuries ago, the Persian hosts were thundering at the gates of Greece. And this same honor was the subject of every Roman noble's story.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

SOME REMARKS ON THE WORKINGS OF A NAVY YARD PAY-OFFICE.

By PAYMASTER DAVID POTTER, U. S. Navy.

While it is realized that an article on the workings of a navy yard pay-office may not be of such universal interest as is a subject relating to the general-mess or kindred matters—such subject having an appeal to every member of the Service, from captain to coal-passer—yet, since the management of a yard pay-office appertains at some time to the duties of nearly two hundred officers of the staff, and its efficiency affects the financial comfort of all officers of the navy and many thousand civilian employees, the preparation of this paper may, perhaps, be justified. It is, however, fitting to premise that these remarks are not intended in any way for the information of those pay-officers of the upper grades whose experience and knowledge are greater than the writer's; but are rather designed to illumine the labors of the comparative tyro whose pay-office assignment is yet a thing of the future. It is, also, hoped to afford some enlightenment to the line-officer who (quoting the recent complaint of a commander) "hasn't the facts about 'pay', and couldn't assimilate them, if he had." Any line-officer in the plight of the commander quoted, who may read this article, is assured that the technical will be avoided as far as possible.

The foremost thing to attract the attention of the officer assigned for the first time to yard pay-office duty is: *the method of handling appropriations is very different from that to which he has been accustomed at sea.* At sea all moneys received are on account of "general account of advances," that safe and convenient "appropriation", from which all disbursements are made without fear of incurring a penalty for breaking the statute

in regard to rendering distinct accounts. The layman may not be aware, by the way, that general-account-of-advances is not really a separate appropriation, but merely furnishes a convenient title to represent the aggregate of all amounts appropriated for the fiscal year.

At shore stations, then, "general account" is not used to cover a multitude of appropriations, but, on the contrary, each appropriation, throughout its entire course, is kept separate and distinct. The estimates-of-funds submitted by the heads-of-yard-departments, the requisitions made therefrom by the paymaster of the yard on the paymaster-general, the allowance of amounts required for, the taking up of the amounts allowed on the books of the pay-officer, the advice to the heads-of-yard-departments of said amounts, the charges for labor on the payrolls submitted by the heads-of-departments to the pay-officer, the record of these charges on the books of the pay-officer, the monthly statements made by the pay-officer to the paymaster-general, to each bureau, and to the auditor for the Navy Department—all these set forth each appropriation separately, distinctly, exactly, without any transfer of funds from one appropriation to another and, therefore, without any charges paid in excess of the amount of the particular appropriation on hand.

In this matter the statute and the regulations must be strictly adhered to—"such transfers never have been recognized by the accounting officers of the Government." That result of much tribulation, the Act of February 27, 1906, Section 3679 of the Revised Statutes, in regard to the use of public funds in excess of allotments, holds all persons concerned in disbursement to a rigid responsibility. Excess charges will, nevertheless, sometimes be made by the heads-of-yard-departments—eager to accomplish necessary work, and contemptuous of statutory limitations which, for the moment, press lightly on unbonded officers—and these charges cannot be known to the pay-officer until the rolls are forwarded to him a few days before pay-day. In such a case, nothing remains but firmly to withhold payment on such rolls—of course, after due consultation with the Commandant—until the head-of-department has obtained an additional allotment of funds by telegraph from the Navy Department. One or two such experiences will make the most recalcitrant wary of exceeding his regular allowance.

In securing distinct accounts of each appropriation *a ledger-of-appropriations becomes indispensable.* This, like the pay-roll on board ship, is the staff of (financial) life for the pay-officer. With it, every receipt and every expenditure by appropriations scrupulously posted therein, a yard pay-office is always ready to balance an account. Without it, laborious shuffling of a confused mass of material may or may not produce a correct result.

Nevertheless, in spite of the vital character of this ledger, no official form of it is, at present, in use. This lack is probably due to the fact that the character of appropriations varies in number and kind at each navy yard. A corresponding variation in the demand for a proper ledger has followed, with the result that none is furnished. Each pay-officer is thus compelled to invent or adopt a form of his own, more or less suitable as his individual genius allows. There are, however, many features of such a ledger which can be employed indifferently at any yard, and the writer sees no reason why a form embodying requirements common to all yards, yet so arranged as to permit sufficient latitude for such changes as the individual may find advisable, should not be adopted at an early date.

The semi-monthly payment of civilian employees is the *raison d'être* and the test of the yard pay-office. Here the object to be attained is speed, speed, and still more speed; for, since the employees must be paid during working hours, every minute unnecessarily consumed in paying off is a loss in dollars and cents to the Government. Celerity of payment is, therefore, the prime requisite, it being always borne in mind, as of course, that accuracy is the basis of all financial transactions, and even celerity must, if necessary, be secondary to this.

Eighteen hundred men can be paid from two windows, in two periods of ten minutes each—or at the rate of forty-five men a minute at each window. Some account of the means by which this speed is attained may be of interest.

The pay-envelopes are placed in thin metal boxes, divided into parallel rows by round-wire partitions, so arranged as to preclude the possibility of the fingers of the payer becoming entangled. Two of these boxes, containing all the envelopes required for the payment, are set on a small wooden stand, constructed for the purpose, and installed at the right of the pay-window. At one minute before the period, the pay-officer, an office-clerk, and

the " time-clerk " of the yard department which is to be paid off, take their places before the pay-window. At a table immediately in their rear and within reach sits the witnessing officer.

The window being opened discloses the employees, lined in order under their respective foremen—the paying off begins on the second.

Each employee as he reaches the window lays his pay-ticket down in front of the office-clerk. This clerk verifies it at a glance, and calls the *number* of the ticket aloud. The time-clerk responds by calling the *name* from the roll in his hands. The foreman, outside the window, confirms the employee's *identity* by a nod. The pay-officer then places the envelope marked with the proper number in front of the employee, who takes it and gives his place to the next man, the entire line moving at a slow walk. The highest practicable speed is thus attained, together with complete accuracy—the latter being insured by the calling of the number of the ticket by the office-clerk (not, it will be observed, by the employee), the co-relation of number and name by the time-clerk, and the confirmation of name and employee by the foreman. It was at first supposed an additional safeguard might be secured by placing the name of the employee on the pay-envelope immediately below his number, but the disbursement of several millions of dollars without any error or complaint has shown such an addition to be unnecessary.

By the method described the rate of speed is only limited by outside conditions beyond the control of the pay-office force, such as the shape and size of the building and of its approaches, the degree of " driving " of the foremen, and the degree of alertness of the employees. It affords an interesting study in physiology to note that men employees move more quickly than women, and boys than either. A more curious psychological matter is presented when it is found that " high pay " employees, such as shipwrights, joiners, boilermakers, and other first-class mechanics, are much more alert at the pay-window than are the " low pay " laborers and helpers—a striking illustration of the fact that a man inevitably rises or sinks to his natural level.

As the pay-officer's financial responsibility is inflexibly fixed by law, so he in turn *must hold all the clerks of the pay-office to an accounting equally rigorous.* No separate funds are placed in the hands of a clerk, except at such times as the pay-officer is

absent from the yard, and then only an amount sufficient to cover probable disbursements. On these occasions the clerk receipts for the amount turned over to him, and, on the return of the pay-officer, accounts for what he has expended.

If discharged men are paid off, the clerk who verifies the pay-ticket attests his responsibility by his initials in pencil on the face of the ticket, near the amount. The clerk who, prior to pay-day, verifies the computations on the payrolls, stamps on the summary: "Computations O. K.," and signs his initials. Similarly, the clerk who goes over the pay-tickets immediately after pay-day, on the lookout for any possible error in name or time, stamps on the pay-roll summary: "Tickets compared with rolls" over his initials. Thus if an error is afterward discovered, the delinquent is at once determinable, not only by particular work falling within the province of a particular clerk, but also by that clerk's initials significantly affixed.

Three things relating to the workings of a yard pay-office should be more explicitly defined by law and regulation. The first is *the financial responsibility of the head-of-yard-department* by whom the pay-rolls are prepared, examined, and approved. Directly, the regulations touch on his responsibility with insufficient emphasis. Indirectly, such responsibility is fixed most emphatically by the words: "he (the pay-officer) shall be responsible only for the correctness of the computations on the mechanics' and laborers' rolls pertaining to the different departments." In spite of this provision, some heads of departments will stoutly deny that they have any financial responsibility whatever, although they alone certify to the correctness of the rolls which they submit. A comprehensive test case, could one properly be devised, might relieve a situation at present fraught with no slight peril.

The second matter in need of clear definition is *the reporting of balances on hand, made by the yard departments each month to the pay-officer.* No regulation exists directing such a report, but plain business sense demands it for purposes of comparison, and custom or local order secures it at most yards. By means of this report the pay-officer is able to know the amount of money a head-of-yard-department *thinks* he has on hand, and the basis of expenditure on which he works. An invaluable check is thus afforded. Since the days and hours worked, and multitudinous

rates of pay enter into the calculations of the yard department, while the pay-office is concerned only with results in dollars and cents susceptible of instant verification, the latter's balance will invariably be the correct one. The monthly report of the head-of-department to his bureau does not pass through the hands of the pay-officer, and the separate report made to the pay-office, in time to allow comparison, will often save the local department much ultimate embarrassment—as many as eight errors have thus been rectified in a single report. So important a matter, therefore, should be enforced by appropriate regulation, and not be left to personal caprice.

The third point involves the *submitting of a pay-roll summary by the head-of-department* with each regular pay-roll. This is a very desirable proceeding on which the regulation is by no means convincing. Not to enter too minutely into the letter of the law, there is genuine confusion in the use of the terms "regular" and "special" with relation to the semi-monthly pay-rolls. A fair-minded reader of the article referred to (Art. 1703, par. 2, U. S. Navy Regulations, 1905) would seem to have no difficulty in carrying out the provisions there set forth; nevertheless, the clerks' pay-roll or the semi-monthly roll may, conceivably, not be considered "regular."

This brings us to the reflection that it is the duty of the pay-officer, as well as of all with whom he deals, *to facilitate business to the utmost of legal power.* Obstructionist tactics or stiffness are almost as much out of place as a downright violation of law would be. The pay-officer is there to "do business," and no artificial restraint should be allowed to stand in his way. On the other hand the law and regulations must be followed—he should yield not an inch through favor, hurry, or indifference, far less retreat before outside opposition and annoyances. These last will be found to be few indeed.

A matter clearly enough laid down by the regulations, but the practical application of which is constantly thwarted by the exigencies of the service, is *the witnessing of all payments to employees by a commissioned or warrant officer.* Theoretically, discharged men must be paid at any time during working hours on presentation of their pay-tickets at the pay-office. A literal carrying-out of this procedure would mean the presence of a witnessing officer in the pay-office during the entire working

day—the witness to be as much a part of the office force as any clerk. With one possible exception, no navy yard has a sufficient number of officers assigned to allow a permanent detail for all-day service in the pay-office. To pay without a witness, needless to say, under the present regulations, is out of the question. The other alternative must, therefore, be adopted, *i. e.*, discharged men can be paid only at certain specified times each day, when the presence of the witnessing officer is assured.

Now, simple as this procedure is in principle, experience has abundantly proved that it will work hardship to many deserving men. A discharged employee cannot afford to wait, perhaps two or three hours, before collecting the pay due him. He loses a train or a boat, and with it goes the job on which he has depended.

Such a condition of affairs is remediable in one way. It being taken for granted that a permanent detail of a witnessing officer for all-day service will never be possible, the remedy lies in altering the regulation so that the witnessing officer is done away with. Why should the civilian employee, who outside the yard gate may be paid any sum on his unsupported receipt, inside that gate, in addition to his own signature and those of his foreman and time-clerk, be compelled to have his interests looked after by a witnessing officer?

At a navy yard where the heads of the various yard departments are at once careful and progressive, no inconsiderable portion of the pay-officer's time is likely to be devoted *to the solution, or rather exposition, of legal questions relating to pay.* It behooves him, therefore, to have ready reference to the published volumes of the decisions of the Comptroller, to the Memoranda for the Information of the Officers of the Pay Corps, to the Revised Statutes and to all possible information. Michael's "Laws," "Manual for the Pay Department, U. S. Army," "Acts and Resolutions Relating to the Navy," &c., have been found of value.

In this connection, what are known as the "manuscripts" of Comptroller's decisions ought to be rescued from so unfortunate an oblivion and win to a calf-bound notoriety as speedily as possible. It is manifestly disturbing to feel that some practice, long sanctioned by such decisions as are by any means obtainable, may be overthrown at any moment by a law all the while lying

perdu in the remote archives of the Treasury Department. A law is "a rule of action," but how can it claim any rights as such if it is never or rarely published even to the most inquiring eye?

Moot-points in regard to the pay of civilian employees present ample opportunity for the exercise of the pay-officer's best discretion—the heads-of-departments rely more than one might imagine on the information he may be able to collate. The industrious compiler of modern instances has here a rich field yet awaiting his efforts. Practically all decisions affecting the pay of officers are matter of common knowledge—the many vexed questions relating to the compensation of civilian employees, such as Sunday and holiday pay, the "time" of men regularly employed every day of the year, sick leave pay under various conditions, compensation for holidays while on leave, to mention only a few, have hardly even reached a satisfactory decision, far less can be considered well-known.

In handling the accounts of officers the pay-master who has had a cruise or two will experience no difficulty and will find little that is new. The separate rates of pay are perhaps somewhat more difficult to determine than those he has been used to, and the adjustment of travel claims must be carefully considered.

Every yard pay-office carries a number of retired officers on its rolls. Immediately after a newcomer into the pay-office has received the transfer pay-rolls from his predecessor, it is highly desirable that he should verify (1) the fact that these retired officers, most of whom he will never see, are actually alive, (2) their signatures, (3) their rates of pay. The last item, in these days of lightning changes, is especially likely to need looking after.

The officers' pay-roll summary, in that it includes charges under many titles, is a little troublesome at first, but here, also, only care is needed.

An important part of the pay-officer's duties—one which almost deserves the dignity of a separate detail—is *the conducting of the sales of condemned supplies.* Sales at a large navy yard are fairly frequent in number, and very considerable in amount. The whole procedure, from the time the first schedule is prepared by the general storekeeper to the time the paymaster of the yard submits the account-sales, demands the most unremitting vigilance

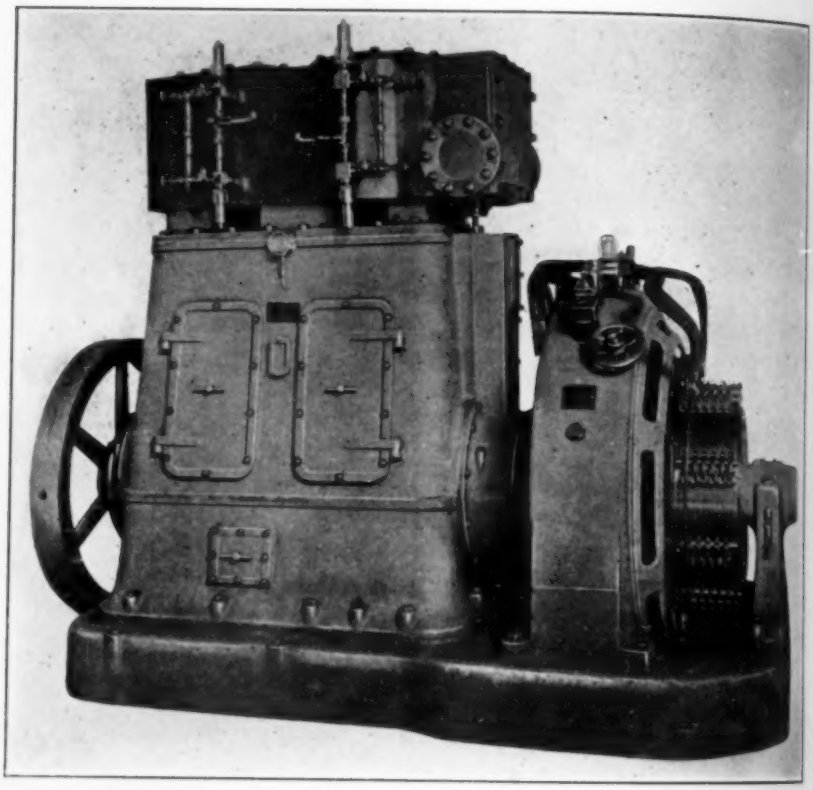
on the part of all concerned. Since the proper conduct of a sale is almost wholly a question of detail, elaborate and important as that is, it cannot be entered into here.

Many *minor matters* help to keep the pay-officer's hands fully occupied. Of such sort are special deposits when work is authorized for private parties—these must be handled in a way all their own. The collection of light, water, and heat charges are others of this class.

The *mechanical aids* in a yard pay-office are mainly those of a well-equipped bank, or large business firm. A reliable adding machine, folder-filing and card-index system, numbering stamp, address machine, roller copier, and a completely equipped fire and burglar-proof vault large enough to accommodate the pay-envelope boxes, have their place. A "change-maker," also, has proved of the greatest utility, and has materially shortened the work of putting up the money for pay-day.

When all is said concerning a navy yard pay-office that would be likely to be of interest here, the fact remains that, as in most affairs, practice is worth a thousand precepts. It would promote efficiency, therefore, and insure the smooth-running of a pay-office, if a junior pay-officer could be assigned as an assistant to the paymaster of the yard or, if this is not possible, if the relief could be on hand a full month prior to the detachment of an incumbent, unless, of course, the relief had already served a tour of duty in a pay-office. This month's instruction would enable the newcomer to observe a great part of the duties af a yard pay-officer in the working, and would fit him for their proper performance when he should be thrown on his own resources.

In conclusion: Since the amount of public funds disbursed by the paymaster of a yard is immeasurably greater than the amount expended by the pay-officer of a ship, the former must bear in mind even more than the other, three fundamental maxims of his profession—he must (1) as far as practicable, keep all moneys himself, (2) pay nothing without proper authority, (3) be eternally vigilant.



100 KILOWATT GENERATING SET.

GENERAL ELECTRIC COMPANY.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ELECTRICAL INSTALLATIONS OF THE UNITED STATES NAVY.[1]

A MANUAL OF THE LATEST APPROVED MATERIAL, INCLUDING ITS USE, OPERATION, INSPECTION, CARE AND MANAGEMENT, AND METHOD OF INSTALLATION ON BOARD SHIP.

By COMMANDER BURNS T. WALLING, U. S. Navy, and JULIUS MARTIN, E. E., Master Electrician of the Equipment Department, Navy Yard, New York.

CHAPTER I.

INCANDESCENT LAMPS.

General Considerations of Naval Types.

The incandescent lamp has at least two great advantages over almost all other sources of light: the first is that it can be turned into any position which will best utilize its light; the second is that the distribution of the luminous intensity of the lamp can be varied within wide limits by the mere shaping of its filament. It is an interesting fact that, while much has been done towards improvements in details, the incandescent electric lamp, as invented twenty-five years ago, is still much the same as the original invention in general appearance and construction. The lamp is essentially a filament of carbon heated to incandescence by the passage of an electric current, the filament being enclosed in an exhausted transparent receptacle to prevent that combustion of its material which would immediately ensue if the material were subjected to high temperature in the presence of oxygen; hence oxygen must be rigorously eliminated and this can be accomplished by exhaust-

[1] To be continued in succeeding numbers of the PROCEEDINGS and on completion to be published in book form.

ing the receptacle by some form of air pump and removing residual oxygen by chemical combination.

The availability of a material for filaments depends upon two qualifications: first, it must be capable of attaining extremely high temperatures without fusing or volatilizing, and upon this qualification depends the efficiency of the material as an illuminant; second, it must be a conductor of electricity.

These two conditions apparently exclude all substances except carbon and the metals with the exception, perhaps, of certain oxides, as a comparison of incandescent lamps, notably those used in the Nernst and Osmium lamps; the oxide types are, however, too fragile for ship use. Practically the conditions narrow the usual selection to carbon, since, as all substances are fused and volatilized at or below the temperature of the electric arc, the arc must represent the best possible source of artificial illumination. The temperature of the incandescent filament is lower than that of the arc and therefore the illumination of the arc must be the superior; still, the temperature of the filament at incandescence is probably as high as 1800° C., a temperature higher than the fusing point of platinum. Carbon, then, not only fulfills the necessary conditions but is at the same time cheap and abundant and possesses the property, unlike metals, of decreasing its resistance with rise of temperature, the resistance of a filament at incandescence being only about half its resistance when cold.

The problem of the filament is to obtain a homogeneous carbon whose specific resistance will be the same in all parts that the filament may not tend to burn away in one section more than in another; and to construct a dense carbon which will not readily disintegrate and blacken with carbon dust the interior surface of the exhausted receptacle, commonly called the bulb; these conditions satisfied, the resistance necessary to the different filaments are readily adjustable by length and cross-sectional area.

The question of selection of a desirable incandescent lamp, apart from those entering into methods of construction, is dependent upon the following considerations:

The Source of Illumination.—This has been determined by experiment to be usually a carbon filament heated to incandescence in an exhausted bulb whose vacuous space is devoid of oxygen.

The Intensity of Illumination.—The number of lumens

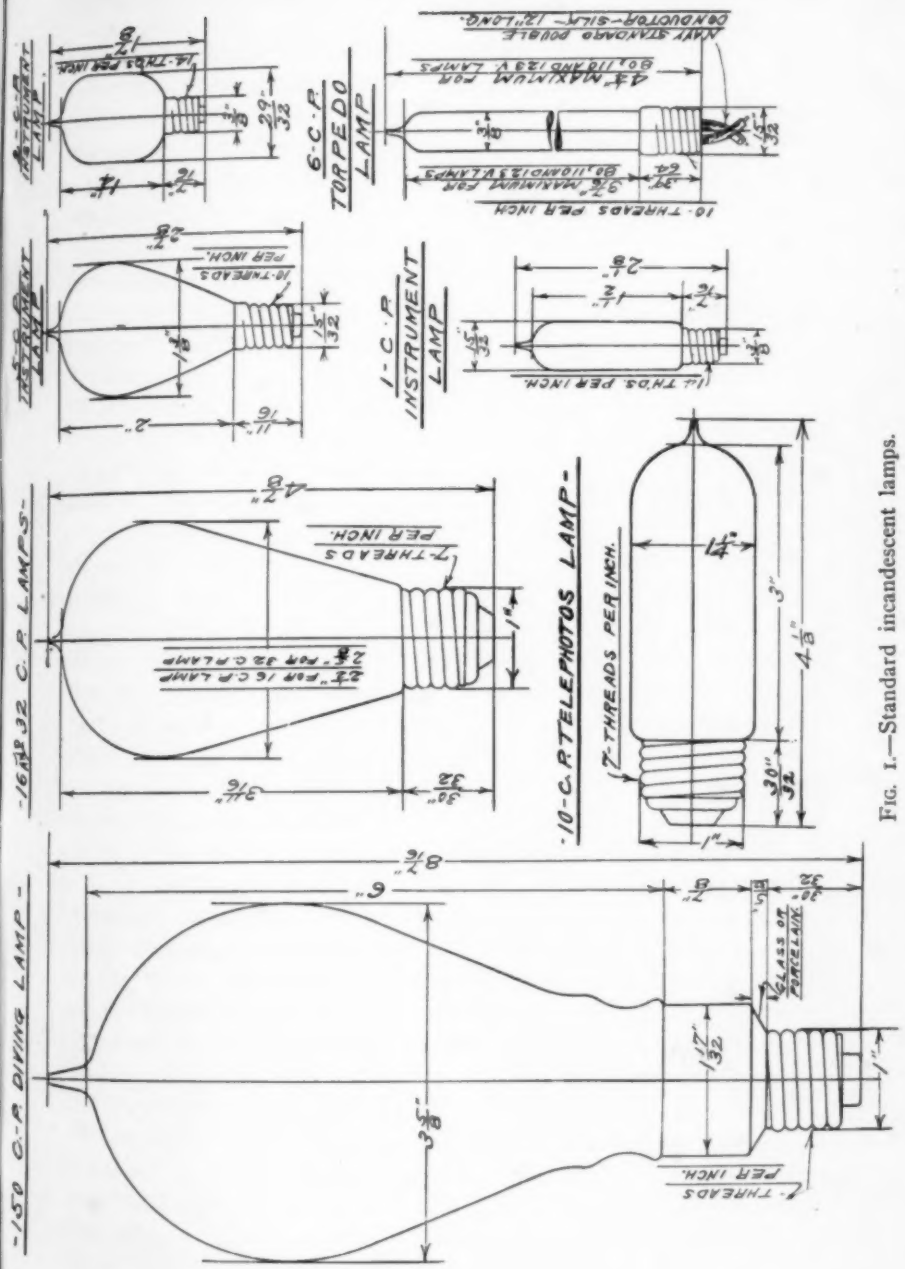

FIG. 1.—Standard incandescent lamps.

emitted from a source of light are measured by reference to the standard candle and are expressed as so many candle-power for the particular source. Types of incandescent lamps are therefore separated in this consideration by the candle-power emissivity for which they are designed, or "rated." Ordinarily comparisons are made on the 16-candle-power lamp which is regarded as the universal practical standard.

In the navy the following candle-powers are used:

Regular Lamps.

16 candle-power.
32 candle-power.
150 candle-power (diving lamp).
5 candle-power (instrument lamp).

Instrument and Special Lamps.

10 candle-power (telephotos lamp).
2 candle-power (instrument lamp).
1 candle-power (instrument lamp).
6 candle-power (torpedo lamp).

All of these classes have their bulbs of clear and transparent glass. In the case of the 16-candle-power lamp a frosted type is allowed, which gives a diminished candle-power after frosting, but the light emitted is softer for reading or for desk use. The different types are shown in outline in Fig. 1. The total number of lamps allowed each ship is on the basis of four for each outlet.

The 16-candle-power lamp is the working lamp for general lighting throughout the ship.

The 32-candle-power lamp is allowed for signals, running lights, truck lights, etc., and can be used to advantage to increase the light in dimly-lighted magazines and shell-rooms where the 16 candle-power originally installed is insufficient. The allowance furnished a ship, however, restricts this type of lamp to navigational and signal use.

The 150-candle-power lamp is supplied for diving use.

The 5-candle-power instrument lamp is for illuminating the indications of "lamp indicating instruments," such as the Helm Angle Indicator, Helm Telegraph, Engine Telegraph, and for lighting binnacles and mechanical telegraphs.

The 6-candle-power torpedo lamp is mounted on the end of a rod for examining the interior of automobile torpedoes and is

made long and narrow that it may be readily inserted in the small orifices in the side of the torpedo.

The 10-candle-power telephotos lamp is an especial form of lamp for the telephotos type of (red and white) lantern of the night signalling lanterns. The lanterns of night signalling sets of the General Electric Company's manufacture and some telephotos lanterns are supplied with a single 32-candle-power standard lamp in each half of the lantern; the usual telephotos lantern requires four 10-candle-power lamps in the red half and three in the white half.

The 2-candle-power lamp is for illuminating the dials of the Fiske type of instruments, and the 1-candle-power for the same purpose in the Cory instruments, no greater intensity being necessary in either case. A 10-candle-power regular lamp is sometimes met with but its intended installation in engine- and fire-rooms effects no good economy when compared with the loss of illumination in those locations.

Lamp Voltage.—The voltage which is to be maintained at the terminals of a given lamp is that voltage which will produce the rated candle-power, at the resistance of the filament, and is restricted by the fact that the life of the filament decreases as the standard voltage is increased, that is, a lower voltage lamp will usually be the longer lived.

The voltage of lamps, except the 1 candle-power (which has an especial voltage of 10 volts for convenience of construction), primarily depends upon the terminal voltage of the dynamos which are to supply the energy. Formerly dynamos have been prescribed for a terminal voltage of 80 volts and the voltage of lamps has been prescribed at 80 volts, mean, between the limits of 78 volts and 82 volts; the variation in limits being allowed in order that a larger number of lamps may be obtained from any manufactured lot than would be practicable if the normal (80 volts) was rigidly prescribed and fixed.

Upon the adoption of the 125-volt dynamos, and for use with the 110-volt machines installed in auxiliaries, both 123-volt and 110-volt lamps have come into use, the 123-volt being now the standard for 125-volt installations. In order to obtain a range of selection, variations in limits are also prescribed for the 123-volt and 110-volt lamps as in the case of those for 80 volts.

A condition which affects the selection of voltage is the ques-

tion of commercial supply and demand, that is, the ability of the manufacturers to fill an order in view of other contracts. For a 125-volt installation a lamp of any voltage between 110 and 124 volts may be used; all types are commonly used by commercial companies at different distances from the power-house to accommodate the lamp to the loss of potential due to distance, or for saving in cost of copper by reason of available reduction in wire size.

The average ratio of supply to demand for 110-volt lamps in the market is as 6 to 9; lamps at this voltage are therefore difficult to obtain, and the case is approximately the same for other voltages up to 119 volts. It is not advantageous, considering the short distances of runs in ships, to endeavor to reduce wire size by using a variety of voltages, and an allowance of 3 per cent drop renders a 123-volt lamp available at all ship distances and necessitates but one type. In the variations of a supply furnished a ship, occasioned by the limits in acceptance, those lamps having voltages lower than 123 are placed at the farther end of lines of wiring, and those nearer to or above 123 volts, in the vicinity of the dynamo-rooms.

Lamp Efficiency.—The economic performance of a lamp is measured by the number of units of energy which the lamp consumes, and this energy is electrically measured by the number of watts required by the lamp, as determined by the product of the current passing through the filament and the voltage at its terminals; this product is called the *total watts*. The total watts divided by the candle-power of the lamp, or the number of watts per candle-power (w. p. c.), is taken as the measure of the lamp's efficiency.

Experiment has determined three practicable efficiencies: 3.1, 3.5, and 4.0 w. p. c. As explained under the subject of voltage, to obtain a range in selection, these efficiencies are prescribed between limits: 2.9 to 3.3 w. p. c., 3.3 to 3.7 w. p. c., and 3.6 to 4.0 w. p. c.

A "high" efficiency of 3.1 w. p. c. will consume the least electric energy for a given lamp of given candle-power, and will give the most brilliant light as compared with lamps of the same candle-power at lower efficiencies, that is, the light will be whitest. The condition obtains only because the lamp at 3.1 w. p. c. is at the highest temperature. In reality no lamp can be said to be of or

have a greater or less efficiency than another: one lamp may be burned, or "run," at a greater efficiency, but it possesses no greater efficiency in itself for the reason that any other lamp can be run at an efficiency just as great; and, further, any lamp can be run at any desired efficiency, approaching in its intensity the electric arc, dependent only upon the temperature, the limiting efficiency being that necessary to the instantaneous destruction of the filament.

Hence, a higher efficiency means a higher state of temperature of the filament; it also means that the filament will burn out more quickly and have a short life. The filament of lamps at an efficiency of 3.1 w. p. c. have the comparatively short life of about 400 hours, and are desirable for those uses alone where extended life is not a consideration as compared with brilliancy, or where a brilliant light is required for but a short time, or intermittently, as in the case of the 150 c. p. diving lamp.

As a life of 1000 hours and above is usually desired and expected, a low efficiency is prescribed for general use; that of the 80-volt lamps heretofore in use is 3.6 to 4 w. p. c., giving long service but showing a yellowish light as compared with the commercial lamp of 3.5 w. p. c. The present standard efficiency is 3.5 w. p. c., between the limits of 3.3 and 3.7 w. p. c., and applies to all classes of lamps except the 150 c. p. diving lamp, whose efficiency is 3.1 w. p. c.

The shorter life of a lamp at high efficiency is taken advantage of in testing the life of lamps from the great saving of time. Though a lamp be *designed* for an efficiency of 3.5 or 3.8 it can be made to burn at any other efficiency by merely altering the voltage, *but it will give a different candle-power from that of the design;* for example, a lamp which is producing 16 candle-power at 80 volts is under life test and it is desired to burn it at 3.1 w. p. c. instead of at the 3.5 of the design; it is only necessary to raise the voltage at the lamp terminals to 82.4 volts, and the efficiency will be 3.1; but the lamp will produce *nineteen candle-power* at the new voltage instead of *sixteen*, and *will consume more electrical energy* than if burned at 3.5 w. p. c.

In addition to changing the efficiency, and farther decrease the time necessary for the life test, it is the custom to burn the test lamp only during its "useful life," or that number of hours in

which its candle-power shall have been decreased to 80 per cent of the rated candle-power.

[NOTE 1.—The high efficiency of the Nernst lamp in particular has of late turned the attention of lamp manufacturers to metal filaments, from which high efficiencies and consequent economy in energy, are readily derivable; the life of the lamp is about 800 hours. One type has a filament made from the metal tantalum which is, however, brittle and has not met with success in alternating current work; the latest development is a tungsten filament, giving the high efficiency of 1.0 w. p. c.; the saving of energy, economy, of this type of filament over the usual carbon filament type is therefore 71 per cent. The type has not as yet been extensively introduced, and it will probably be many years before the carbon filament lamp is importantly supplanted.]

The Type of Bulb.—The type of bulb is a question of dimension for filament area and for the intended use; the commercial "straight side," or "parachute" bulb is the approved standard.

The Type of Base.—The Edison screw base is in such general use and is so well adapted for securely holding a lamp in place that it has been the permanent standard.

Lamp Manufacture.

The Filament.—The original compound is a pyroxylin made from cotton. The steps of reduction to cellulose vary with different manufacturers, but the main reactions are as follows: The pyroxylin is dissolved by hot concentrated 40 per cent zinc chloride forming a syrupy mixture from which a hydrated cellulose zinc-oxide is precipitated by alcohol. The zinc is freed by hydrochloric acid and washing. The pyroxylin is reduced to cellulose by ammonium sulphide. The resulting compound is a heavy, brownish or amber-colored liquid known as "tamadine," and of the consistency of heavy molasses.

The liquid is put in an inverted bottomless jar, over which is fitted a cap for application of a light air pressure; the neck of the jar is fitted with a pipette nozzle, the diameter varying for the diameter of the filament to be produced. The liquid oozing through the nozzle passes in a thread to a "tub" placed in a slowly-revolving jar which is filled with alcohol to harden it. The tubs undergo several washings to remove the adhering zinc chloride; acidulated washes are sometimes used to remove any stickiness of the surface. In this state the thread becomes a milky-white cord resembling, and a little thicker than, boiled vermicelli.

The cord is thoroughly dried on the surface of a slowly-revolving drum, which is heated internally by gas or steam; drying to a tough, flexible, lustrous thread resembling a white horse hair. In this state it is wound about the posts of a former, or mandrel, having a large and small post; turns are taken around the larger post before crossing to the other in accordance with the number of turns, or spirals, desired in the finished filament. The spirals on the mandrels are slightly baked in an oven to ensure temporary retention of form, and are then cut at the smaller post and taken off the mandrel.

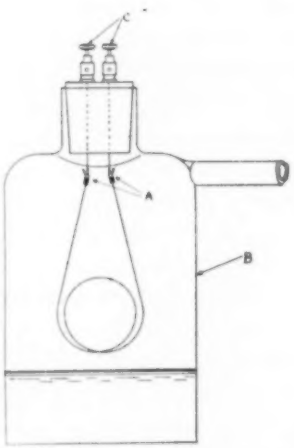

FIG. 2.—Bottle for flashing or treating.

The filaments are then packed in metal boxes filled with peat and brought to a red heat in an oven; this process gives all the shrinkage that will result in carbonizing; at this stage the filament is not yet a conductor of electricity.

The filaments, now of a black color, are packed with a refractory material in plumbago crucibles and carbonized, retaining the formed shape permanently; they are separated carefully and the ends trimmed to the finished length.

The manufacture of the filament thus far assures neither homogeneity throughout nor the appropriate resistance; both are accomplished by the following ingenious process, known as "treating" or "flashing":

The filament is connected by clips (*A*, Fig. 2) in the air-tight cork of a bottle *B*, which contains a volatile hydrocarbon such as

gasoline, benzine, etc. The clips are metallically connected with the binding posts, *C*, to which wires from a source of electricity at proper voltage are connected through a clutched switch and an ammeter (not shown). When the switch is closed the terminals, *C*, are at a slightly higher potential difference than that at which the lamp is to be used. The bottle is first exhausted, the switch is closed, and the filament (within the bottle) becomes incandescent. The heat decomposes the vapor emitted by the hydrocarbon and deposits carbon on the filament; those sections of the filament which have the greatest resistance (or which are of least diameter) will heat most and receive the greatest deposit of carbon, and proportionately for differences in diameter; the whole filament thus becomes homogeneous and uniform in resistance throughout, no section tending to heat more than another.

As the carbon is deposited the resistance decreases and the current increases. The pointer of the ammeter moves along the scale to an indication where the desired resistance, and consequently current, has been reached; at this point the pointer closes a circuit which automatically shunts in a current from another circuit and which in turn throws out the switch clutch; the switch springs open and cuts off the current from the filament, stopping any farther deposition of carbon.

It is optional whether the filament be suspended in the vapor above the liquid in the bottle or be submerged; results of test show that filaments flashed in the vapor are less likely to cause blackening of the bulb than when treated by submerging. The latter process is sometimes used because it is the cheaper and is also the safer from explosions occasioned by access of air.

In making the filament the length and cross-sectional area are the considerations sought in homogeneous material in determining the resistance for a required candle-power at the voltage at which the lamp is to be burned.

Filaments of the 150 c. p. diving lamp are made either of tamadine or carbonized split bamboo, but neither style of filament have as yet proved successful in this type of lamp.

Tamadine filaments are usually known to the trade as "squirted" filaments.

Figs. 3 and 4 show the different types of filaments of naval incandescent lamps. The spiral type (*C*, Fig. 3) was used in 80-volt lamps of 16 and 32 c. p., having the old cruiser type of

bulb, now obsolete. The oval type (*E*, Fig. 4) is used in those having the present parachute standard bulb for the 16 and 32 c. p., and in the 10-candle-power telephotos lamp. The practical difference between the oval and spiral filaments is that the oval is anchored while the spiral is not.

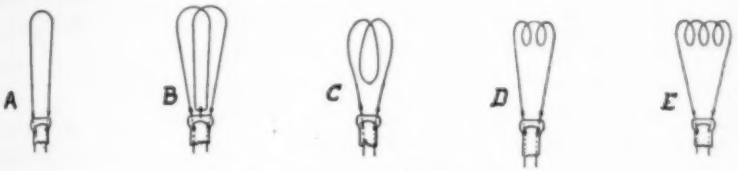

FIG. 3.—Types of filaments.

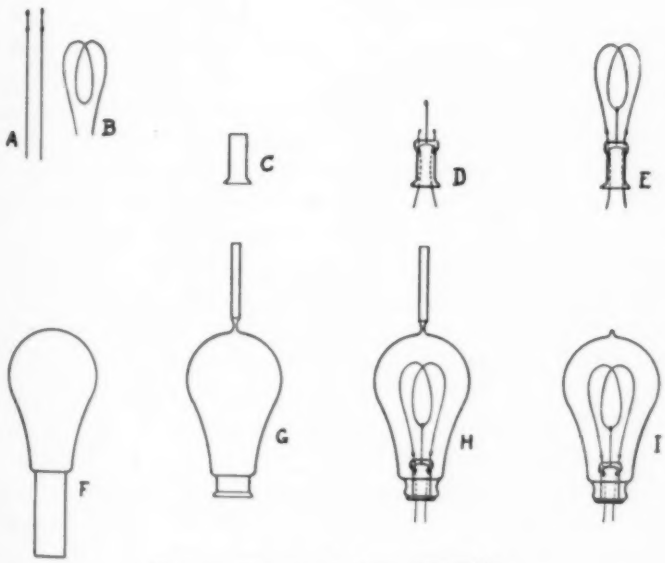

FIG. 4.—Stages of lamp assembly.

The filament of the 150 c. p. diving lamp is made in a two-coil spiral (*D*, Fig. 3) for the 80-volt type; that for the 123- and 110-volt types is a double loop, or double "horse shoe" (*B*, Fig. 3), the loops being set at right angles and in series with each other.

The filament of the 5 c. p. is a two-coil spiral (*D*, Fig. 3). That of the 2 c. p. is a double loop for the 80-volt type and a three-coil spiral (*E*, Fig. 3) for the 123-and 110-volt types.

The filament of the 1 c. p. lamp is a single loop (*A*, Fig. 3),

as is also that of the 6 c. p. torpedo lamp; the long filament of the 6 c. p. is ordinarily anchored to the tip of the bulb instead of to the flyer to obtain better centering and steadiness.

The Flyer.—Two 3-inch copper leading wires are first attached to two platinum wires, each about ½ inch in length (*A*, Fig. 4); the copper wire is heated in a blow lamp and the platinum wire forced into the fused end of the copper, making a secure joint. Notwithstanding the comparatively great expense entailed by the use of platinum for these lamp ends (which are to be fused into the glass of the flyer) no other metal so well serves the purpose: first, because platinum will not oxidize at the high temperature necessary for fusing the glass, hence the joint will be tight and not cause a leakage of air into the vacuous space; second, as the coefficients of expansion of glass and platinum are practically the same, the expansion of the metal is not likely to crack the glass of the flyer and admit air.

The combination of the copper and platinum leading wire is next assembled in a glass tube having a bell-shaped mouth (*C*, Fig. 4), the platinum wire being fused in the glass. The finished flyer is shown at *D*. The wire shown in the center of the flyer is of metal, usually copper, and is called an anchor; its office is to secure the bottom of the filament spiral, thus centering the filament, steadying it against vibration, and preventing it from swinging against the glass of the bulb; it requires but a light touch of the incandescent filament to fuse the glass, collapse the bulb at the point of fusing, admit air, and destroy the filament.

The filament ends (*B*, Fig. 4) are next attached to the platinum wires of the flyer, and the spiral to the anchor, by a non-fusible cement, or carbon paste, called a "*clamp*"; the date of manufacture is written in ink on the surface of the glass of the flyer, and the combination of this stage (*E*, Fig. 4) is ready for inserting in the bulb.

The length of the flyer for the 80-volt, 110-volt, and 123-volt types is not the same, due to the difference in length of the filament.

The Bulb.—The construction of the bulb is purely a glass manipulation. *F*, Fig. 4, shows the bulb as received from the glass factory; *G*, at the stage at which the flyer is fused in.

The assembly of the bulb and flyer consists in carefully inserting the combination shown at *E*, Fig. 4, into the bulb, *G*, and

fusing the edges of the bell mouth of the flyer to the edge of the bulb; the finished product is shown at *H*, in which stage the lamp is ready for exhausting.

Commercially standard bulbs are generally denoted by a number which represents their diameter in eighths of an inch; thus a 2⅝-inch bulb is designated as No. 21.

Forming of the Vacuum.—Upon the best performance of this office depends that vital consideration, the life of the filament, and consequently the life of the lamp; the *rationale* of the method is the elimination of oxygen.

The narrow tube which is shown attached to the top of the bulb, *H*, Fig. 4, is coated internally with a red chemical compound, a trade secret, but containing red phosphorous which takes up the residual oxygen in the bulb when heated forming a transparent phosphoric acid gas. The end of the narrow tube is next inserted in the air-tight rubber bushing of a tube connected with a mechanical, Sprengel, or Weston, type of air pump and exhausted until the attached column of mercury shows about 30 inches. The copper leading wires of the lamp are now attached to clips on two wires which are fed at the potential at which the lamp is to be run and the current is turned on. The color of the bulb will now be a *pale blue*.

A blow-pipe flame is applied gently to the narrow tube until the red chemical volatilizes and disappears and the lamp shows a *clear or bright yellow;* the narrow tube is then gently seared over ("sealed") next the bulb and twisted off, leaving the little nipple generally seen on incandescent lamps. *I*, Fig. 4, shows the lamp at this stage.

The bulbs are now tested for vacuum by brushing the leading wires against a plate attached to one electrode of a Ruhmkorff coil, the lamp being held in the hand. The sufficiency of the vacuum is judged by the color and the appearance of the light inside. The bulb is then ready for the base.

Attaching the Base.—The Edison base consists of a threaded spun brass open-ended cylinder, perforated with one hole near the middle of its length, and a brass disc perforated through its center. The method of attaching the base, using plaster of paris only, is as follows:

The combination (*I*, Fig. 4) is put in a frame moving perpendicularly, the cylinder is centered under the frame and the disc

is entered at the bottom of the cylinder. The copper leading wires are threaded, one through the perforation of the cylinder, the other through the center of the disc, and the cylinder is filled with plaster of paris.

The frame is now pushed down and the wires drawn through. As soon as the plaster hardens the overflow is trimmed off, the leading wires are cut close to the cylinder and disc and soldered. The bottom of the base is then coated with shellac and the lamp is finished. This method, though common, has the serious objection that, notwithstanding the protection afforded, the shellac proves unequal to keeping out moisture when the lamps are stored in such moist locations as ship store-rooms; the plaster of paris being hygroscopic, sufficient moisture is taken up to cause a short circuit between the copper leading in wires in the lamp base which cannot be readily removed by drying.

A second method considerably in vogue is to crimp the bottom of the cylinder and cement in a treated porcelain plug or button in which the brass disc is imbedded; the bulb is secured to the cylinder by a moisture proof cement. The porcelain plug has channels for the leading wires to the disc, and to the side of the cylinder, or to a bottom edge if so connected. It is important that the porcelain insulate between the leading wires. The channels should be carefully filled with some water repellent substance. The method has the same objections cited for plaster of paris, but in a lesser degree.

The latest method, in which a glass plug is used instead of porcelain, is an improvement on the last. The plug is made by forming melted glass in the crimp of the base, the contact piece being secured by rivet attachment. In this method but one channel is necessary, the other leading in wire being soldered at the top of base.

The bases of the 150, 32, 16, and 10 c. p. lamps are required to be of standard form of Edison base. The base of the 5 c. p. is of the candelabra form of Edison base. The bases of the 2 c. p. and 1 c. p. are of the minature form of Edison base.

Test of Voltage.—The lamps are next "run through" a photometer to measure the voltage at which the rated candle-power is maintained, the screen being moved along a scale marked in volts, the lamp rotating at 180 revolutions per minute. All that is sought in the commercial test is to ascertain what voltage the

particular lamp requires for the rated candle-power; this complying with specifications, the watts per candle-power and actual candle-power are taken as correct. Lamps have heretofore been marked for the rated candle-power and rated (not actual) voltage; a mark showing the actual voltage to the nearest volt is now shown on the label.

Life Test.—A number are selected and started on a life test (useful life being tested) for loss of candle-power in the interval.

Frosting.—The bulbs of those lamps which are to be frosted are, after being tested for voltage, submerged in a solution of hydrofluoric acid and ammonium chloride; the operation requires but a fraction of a minute.

Inspection and Test of Incandescent Lamps.[2]

In order that there may be no misunderstanding as to what will be expected of a delivery of incandescent electric lamps the inspection and tests which the lamps will be subjected to are prescribed in the specifications substantially as follows:

All lamps are to conform in their general shape and form to the official drawing, from which Fig. 1 is taken.

The overall dimensions of the standard 32, 16, and 5 c. p. lamps must not exceed the dimensions in inches in the following table, in order that they may fit in the standard types of fixtures:

TABLE 1.

	32 c. p.	16 c. p.	5 c. p.
Length overall	4 7/8	4 7/8	2 7/8
Length of bulb without tip	3 1 1/16	3 1 1/16	2
Maximum diameter of bulb	2 5/8	2 1/2	1 3/8

The overall dimensions of the 150 c. p. (diving), 10 c. p. (telephotos), and 2 c. p. and 1 c. p. (instrument), and 6 c. p.

[2] All inspections and tests herein explained are those in current practice in the Equipment Department of the New York Navy Yard.

For the sake of brevity, it may be here stated that in addition to items of specification (which are alone taken up in the descriptions following), the blank forms used by that department, largely inaugurated in the department itself, are made complete as to details and features of the article under inspection, the marks of manufacturers, workmanship, accessories, dimensions—in short, any detail for recognition, future requisition, or incidental and necessary to repair. A photograph of a new article is always taken in three views, and often the whole is disassembled and all parts photographed.

(torpedo) lamps must conform to the dimensions shown in the official drawing.

The lamps must be made of the very best materials, and must be of the best quality and finish and uniform in size.

The filaments must be centered in the bulb and, in the case of the 32 c. p. and 16 c. p. lamps, must be anchored. They must not droop appreciably during the life of the lamp when the lamp is run in a horizontal position.

Each lamp must have its rated candle-power and the voltage (to the nearest volt) necessary to give this candle-power, and the name or trade-mark of the maker shown on a printed label or otherwise clearly or indelibly marked on the bulb.

The lamps must be so designed that when burned at the rated mean horizontal candle-power the volts and total watts will not fall outside of the limits prescribed by the table on opposite page.

Measurements for mean horizontal candle-power are to be made by revolving the lamps at about, and not less than, 180 r. p. m. with the axis of the lamp vertical. When making this determination the lamps shall be so placed in the photometer that the horizontal line through the center of the screen will cut the lamp at its maximum diameter.

From each barrel or lot of 200 lamps there will be selected at random 10 lamps for the purpose of determining the initial voltage, and the total watts at the rated candle-power, and the physical characteristics of the lamps. These lamps will be known as test lamps. If the voltage or total watts of any two of the test lamps from any barrel or lot of 200 lamps is found to fall beyond the limits allowed in Table 2, above, 10 more lamps will be selected at random from the same barrel or lot, and if any one of these additional lamps is found to fall beyond the allowed limits of voltage and total watts, the entire barrel or lot will be rejected without further test. If the voltage or total watts of more than two of any lot of 10 test lamps falls beyond the allowed limits, the barrel or lot from which these lamps were selected will be rejected without further test. If any one of the 10 test lamps selected from any barrel or lot of 200 lamps shows a poor vacuum, a loose base, a spotted or discolored filament, or any other physical defect incompatible with good workmanship, good service, or with any clause of these specifications, 50 lamps will be selected from this barrel or lot, and should 10 per cent of these 50 lamps

TABLE NO. 2.

1	2	3	4	5	6	7	8	9
Class.	Rated candle-power.	Standard total watts.	Type of filament.	Individual voltage limits.	Individual total watt limits.	Candle hour area at rated efficiency.	Candle hour area at 3.1 W. P. C.	Test candle-power to give 3.1 W. P. C.
SPECIAL LAMPS.								
Instrument.								
1 candlepower, 10 volts, clear....	1	4.9	Loop.....	9.25–10.75	4.5– 5.3	552	68	2.02
2 candlepower, 80 volts, clear....	2	11	Double loop..	78– 84	10.1–11.9	1,288	92	4.79
2 candlepower, 110 volts, clear...	2	13	3-coil spiral..	106–116	12–14	1,472	55	6.1
2 candlepower, 123 volts, clear...	2	13	....do.....	119–129	12–14	1,472	55	6.1
Torpedo.								
6 candlepower, 80 volts, clear....	6	30	Loop.....	77– 85	27–33	138	15.4	12.5
6 candlepower, 110 volts, clear...	6	30	....do	106–116	27–33	138	15.4	12.5
6 candlepower, 123 volts, clear...	6	30	....do.....	119–129	27–33	138	15.4	12.5
Telephotos.								
10 candlepower, 80 volts, clear....	10	36	Oval.....	75– 83	34–38	3,680	1,840	12.5
10 candlepower, 110 volts, clear...	10	36	....do.....	104–112	34–38	3,680	1,840	12.5
10 candlepower, 123 volts, clear...	10	36	....do.....	119–127	34–38	3,680	1,840	12.5
REGULAR LAMPS.								
Regular.								
5 candlepower, 80 volts, clear....	5	19.5	2-coil spiral..	80– 86	18–21	2,760	1,200	7.14
5 candlepower, 110 volts, clear...	5	19.5	....do.....	110–117	18–21	1,150	800	7.14
5 candlepower, 123 volts, clear...	5	19.5	....do.....	123–131	18–21	1,150	500	7.14
16 candlepower, 80 volts, clear....	16	56	Oval.....	77– 82	53.2–58.8	12,000	8,000	19
16 candlepower, 80 volts, frosted .	16	56	....do.....	78– 83	53.2–59.8	12,000	.....	19
16 candlepower, 110 volts, clear...	16	56	....do.....	107–112	53.2–58.8	12,000	8,000	19
16 candlepower, 110 volts, frosted.	16	56	....do.....	108–113	53.2–59.8	12,000	....	19
16 candlepower, 123 volts, clear...	16	56	....do.....	121–125	53.2–58.8	12,000	7,000	19
16 candlepower, 123 volts, frosted.	16	56	....do.....	122–126	53.2–59.8	12,000	.....	19
32 candlepower, 80 volts, clear....	32	115	....do.....	76– 82	109–121	20,000	11,000	40
32 candlepower, 110 volts, clear...	32	115	....do.....	106–112	109–121	20,000	11,000	40
32 candlepower, 123 volts, clear...	32	115	....do.	120–126	109–121	20,000	11,000	40
Diving.								
150 candlepower, 80 volts, clear ...	150	465	2-coil spiral.	76– 82	442–488	13,800	13,800	150
150 candlepower, 110 volts, clear...	150	465	2 loop.....	106–112	442–488	20,700	20,700	150
150 candlepower, 123 volts, clear...	150	465	....do.....	120–126	442–488	20,700	20,700	150

[NOTE 2.—Frosted lamps are not tested at 3.1 w. p. c.]

be found to have any of the physical defects above mentioned, the entire lot from which these lamps were selected will be rejected without further test.

From the 10 test lamps selected from each barrel or lot of 200 lamps passing the above tests for voltage, total watts, and physical characteristics, one lamp shall be selected and shall be known as a life lamp. This lamp shall be the one from each lot of 10 test lamps which measures closest to the mean of the limits for volts and total watts as given in columns 5 and 6 of Table 2, above. From the life lamps so selected a given number will be tested for candle-hour performance, and this test will be known as the life test. The number of lamps that will be put on life test will depend upon the number of lamps delivered.

When lamps are purchased in lots of 2000 or less, 10 lamps will be selected for life test; in lots of from 2000 to 5000, 20 lamps will be selected; in lots of from 5000 to 10,000, 30 lamps will be selected; in lots of from 10,000 to 30,000, 50 lamps will be selected for life test. The lamps selected for life test will be brought to that value at which the lamp burns at 3.1 watts per mean horizontal candle-power. Throughout the life test each lamp will be burned at the particular voltage which was required to give 3.1 w. p. c. initially. The average value of the candle-hour performance of the lamps subjected to life test shall not be less than the amount in column 8, Table 2, above.

The candle-hour performance of a lamp will be calculated, as described below, from the observed values of the mean horizontal candle-power measured at the beginning of the life test, and at intervals thereafter of 25 hours during the first 100 hours, and thereafter at intervals of not more than 100 hours until the lamps shall have burned out, or fallen to 80 per cent of its test candle-power. In case a lamp burns out, its candle-power at the time of the burn-out will be assumed equal to the last observed candle-power. The candle hours given by a lamp during any one of the intervals of 100 hours or less, as above, will be considered to be the product of the hours denoting the duration of that interval, and the arithmetical mean of the observed values of the mean horizontal candle-power measured at the beginning and at the end of such interval; provided, that if any observed value of the mean horizontal candle-power exceeds the test candle-power by more than 3 per cent, such candle-power shall, in computing the

candle hours, be given a value of 3 per cent greater than the test candle-power. The candle-hour performance of the lamps will be considered as the sum of the candle hours given during each of the observed intervals, and up to that time when the lamp shall have burned out or shall have fallen to 80 per cent of its test candle-power.

Test for vacuum will be made with an induction coil previously set for a ⅜-inch spark for regular lamps, and suitably reduced for small lamps having delicate filaments.

The standards of candle-power which will be used in making the above-described tests will be those held in the Equipment Department at the Navy Yard, New York. Any person having a contract for lamps may send to the Equipment Department, Navy Yard, New York, a set of 10 seasoned lamps to be standardized, one-half of which will be returned, and the other half retained for future reference.

All lamps whose bulbs shall burst, or whose filaments shall break under test or in transit will be rejected from the delivery, and must be replaced at the expense of the contractor. In order to avoid duplication of the life test, no test will be made on any class of lamps until the entire number of such lamps on any contract is delivered, unless it is specified in the contract that partial deliveries are to be made at stated times. In case partial deliveries are required, the entire quantity of each class of lamp constituting the partial delivery must be received before any tests will be undertaken.

Mechanical Construction.—The maximum diameter of the bulb is tested by means of a gauge ring which has an inside diameter equal to the greatest allowed diameter of the lamp, as per table; the lamp must pass through this ring without effort. Two or three other diameters of the bulb and the diameter of the base are calipered. Lengths are measured for correspondence with the prescriptions of the standard drawing. These dimensions are important, to insure fit in standard fixtures.

Examination is made of the following:

That the threads of the base are of the prescribed number and pitch, in order to insure a fit in the standard socket.

That the bulb is securely cemented to the base, and that the cement is moisture proof; tested by placing the lamp under water for an hour or two and wrenching the base.

That the button is so placed that it will insure insulation between the contacts and that the channels are fitted with a water-repellent substance. After the soaking test the lamp is placed in a socket; if short-circuited it will not burn or will burn faintly.

That the leading-in wires are securely soldered to the bottom contact and to the side cylinder; and that they are of copper and have platinum ends in the fused part of the flyer.

That the filament is centered in the bulb and, if anchored, that the anchor is of metal and is securely fused into the flyer.

That the quality and finish is of the best, judgment being rendered by comparison with a standard sample.

That the lamp is properly labeled for its rated candle-power and the actual voltage, to the nearest volt, which is required to give that candle-power.

That the filament is securely fastened to the leading-in wires and to the anchor. Usually this determination is not definitely demonstrated by examination; as a rule the performance of the lamp on life test will show it, as the filament is likely to separate from the platinum wire if the clamp is poor.

The date of manufacture must be noted, and if not within three months of the date of delivery examination of records is made to insure that the lamp is not of a lot that has been previously tested and rejected.

Photometer Test.—In ordinary photometer tests the problem is to ascertain the unknown candle-power of a source of light by comparison with a standard flame or candle, and, incidentally, the rate of consumption of the material which maintains the source. In photometric measurements of incandescent lamps the problem is to ascertain the consumption of electric energy in a lamp of designed, or *rated*, candle-power by measuring its voltage and current when burning at that candle-power; the product of these two measurements gives the total watts consumed, from which the efficiency can be calculated by dividing by the candle-power.

The photometer used is shown in Fig. 5; it was constructed at the navy yard.

The bed of the photometer, *A*, is a steel I-beam mounted on heavy cast-iron standards. It carries a steel scale, divided, first, to read directly in candle-power; second, in tenths of an inch

over a length of 60 inches, the total distance between sockets for the standard lamp and the lamp under test.

The photometer carriage, *B*, runs on ways provided on the upper side of the photometer bed, and carries the photometer screen, *C* (the Lumner-Brodhun is shown, the ordinary Bunsen screen is shown detached at *D*). The screen has an index line

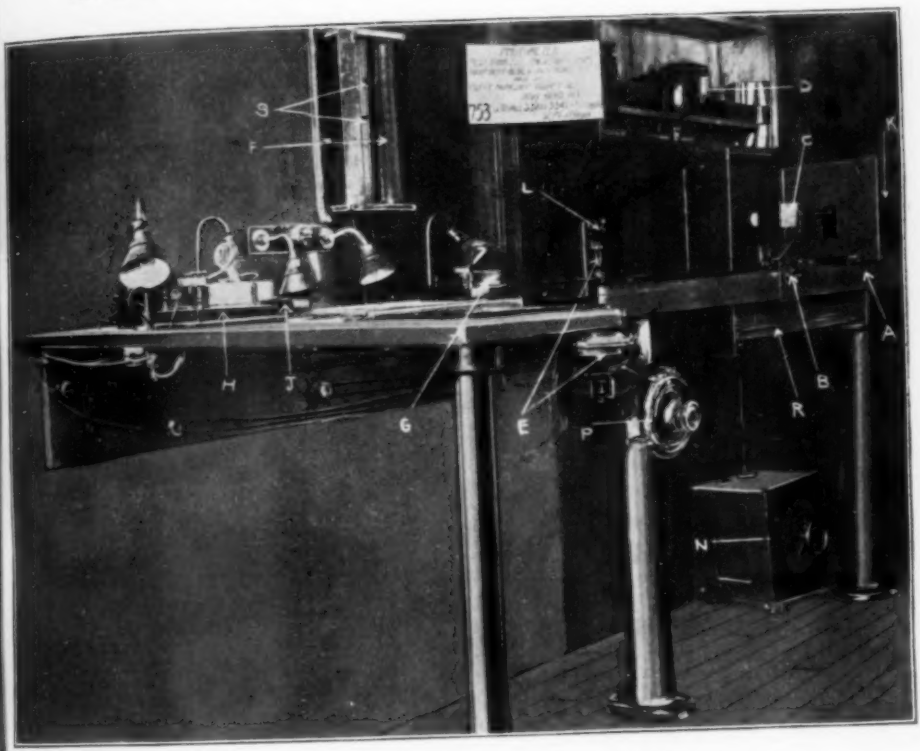

FIG. 5.—Photometer, New York Navy Yard.

giving its exact center with reference to the photometer scale; a pin fixes the screen at the 16 c. p. and 32 c. p. divisions, on its rear side is a clamp for holding at any position. For taking readings on lamps of unknown candle-power (when the carriage is to be varied in position) an instrument lamp is provided which illuminates the photometer scale at the index line; this is lighted by pressing a button, also on the carriage.

At the right-hand end of the photometer is the socket, *K*, for

the standard lamp, which can be turned about its vertical axis to any angle, as indicated by a graduated circle, and clamped fast in the position by a set screw. An adjustment for height (by collar and set screw) are also provided; when correctly set, the center of the loop in the lamp filament will correspond with the center of the photometer screen.

The rotator, *E*, for the lamp under test, *L*, is at the left-hand end of the bed. This consists of a socket rotated at a constant speed of 180 r. p. m. by a direct-connected, ⅙ h. p., motor; electrical connection is made to the lamp by means of two mercury cups. The speed of the motor is regulated by a rheostat of the Carpenter type, *P*. The motor is stopped and started while the lamp is being replaced by a switch operated by the laboratorian's foot. A snap switch is provided in the rotator circuit.

The rheostat, *F*, regulates the voltage of the standard lamp; it is wound with No. 22 German silver wire, total resistance 69.5 ohms. The insulated resistance wire is spooled over a brass tube and a section of the surface is bared for contact with sliders, *S*, in series with the rheostat and the standard lamp. When the sliders have been advanced to the "all-out" positions on the rheostat resistance, there will still be a resistance of 1.5 ohms in circuit due to the rheostat.

The rheostat is so located as to be conveniently in reach of that observer who is reading the voltmeter, *G*, which is connected across the standard lamp, and the voltmeter, *H*, and ammeter, *J*, connected for reading the voltage and current of the test lamp.

The rheostat, *R*, similar in construction to *F*, is in the circuit of the lamp under test, and is placed on the photometer bed so that the observer at the screen can adjust the voltage of the test lamp to that necessary for obtaining the proper intensity of light on the test lamp side of the screen. Three coils are shown in the rheostat, of which the smaller is for fine adjustment of the voltage.

When the intensity of the light on both sides of the screen is equal (or "balance" has been obtained) the voltmeter, *H*, will indicate the voltage of the test lamp for balance. The rheostat, *N*, is used as a shunt for tests of the 150 c. p. lamp, whose current, 6.25 amperes, would be likely to burn out the rheostat, *R*, if *N* were not paralleled across the circuit.

The voltage of the standard lamps varies from 48 to 50 volts, but the rheostat, *F*, contains enough resistance to cut down the line voltage to the proper value for these lamps when 125-volt lamps are under test.

The rheostat, *R*, controlling the lamp under test is wound with No. 18 German silver wire; total resistance, 54.7 ohms.

Resistance of top coil.....24.7 ohms.
Resistance of 2d coil ..... 7. ohms.
Resistance of bottom coil .....23. ohms.

Reading lamps are placed over the instruments and are so shaded that light is thrown on the instrument scales only. These are instrument lamps of 2 c. p. at 80 volts, a 32 c. p. lamp being placed in series to cut down the voltage from the 110 volts necessary for the motor.

The Bunsen Screen.—A spot of grease on a sheet of white paper is placed normal to the optical axis of the photometer; the spot disappears when the paper is equally illuminated on both sides. The spot is central and the field is viewed by 45-degree mirrors set on each side of the screen.

The paper used is Whatman's I A H double elephant; the grease spots are prepared by dipping a warmed disc of brass, about ⅝-inch diameter, into a paraffin bath; this, after dripping a little, is pressed on a large sheet of paper in a number of places and the excess paraffin removed from the spots by the aid of a sheet of blotting paper pressed by a moderately hot flat-iron. The best spot is then chosen.

The photometer should readily show a difference of 2/10 volt in a 3.6-watt, 80-volt, 16 c. p. lamp with the Bunsen screen, one lamp revolving. With the Lumner-Brodhun screen and stationary lamps, as in checking standards, observations by two persons should check within 1/10 volt.

The Lumner-Brodhun Screen is shown in diagram in Fig. 6 It consists of a gypsum, or MgO screen, held normal to the optical axis, each face of which is illuminated by one of the lamps under comparison. Two prisms are provided, one of the hypothenusal sides being so recessed and held as to be in contact only at a portion of the length, as shown. The eye at the reading telescope sees a uniformly illuminated field when the faces of the screen are equally illuminated. One face of the screen is seen by

reflected light, the other by the light transmitted through the prisms; this is reversed by turning the box through 180 degrees, the surface seen in the first position by reflection being seen by transmitted light in the second.

The trapezoidal-shaped figures of the sight field are illuminated by light from the regions marked 4 and 5 only; the light of the regions 2 and 7 does not pass to the eye piece at all and the *field*, as distinct from the trapezoidal *figure*, is illuminated from the test lamp source by the rays 6 and 8 and from the standard lamp by the rays 1 and 3. Hence, there will be contrast between the figure illuminated by 4 and the field illuminated by 1 and 3 on each side of it, and similarly there will be contrast between the figure illuminated by 5 and the adjacent field illuminated by 6 and 8 but in the opposite sense to the contrast for the figure illuminated by 4. There will also be a contrast at the medial line of the sight field between the spaces illuminated by 3 and 6. These three contrasts in different positions enable the operator to check his balance quite accurately, and more so than is practicable with the Bunsen screen.

The Lumner-Brodhun screen can also be fitted with absorption strips (as shown in the path of the rays 1, 3, 6, and 8), interposed in the path of the light from both of the sources; their use is unnecessary when the lights from the two sources are of the same color, and are used only when the lights from the two sources are of different colors.

The rays 1 and 3 from the standard source, and 6 and 8 from the test source, pass through the absorption strips to illuminate the fields but do not illuminate the trapezoidal figures, the figures being illuminated by the active light from each source. There are, therefore, two methods of comparison; by contrast of the active lights from the sources, and by contrast of those active lights as affected by absorption, the comparison being made by contrasting the illumination of the trapezoidal figure with the field immediately adjacent to it. There is also the difference in illumination across the medial line of the sight field, or three ways can be utilized as before but, due to the absorption strips, the contrast between the trapezoidal figures and the adjacent fields will be intensified.

In testing, a Tertiary standard lamp is placed in the socket at *K* (Fig. 5), and used as a standard for the lamps to be tested; it

DIAGRAM SHOWS SCREEN IN POSITION FOR TAKING FIRST READINGS IN COMPARISON OF STANDARD LAMPS;

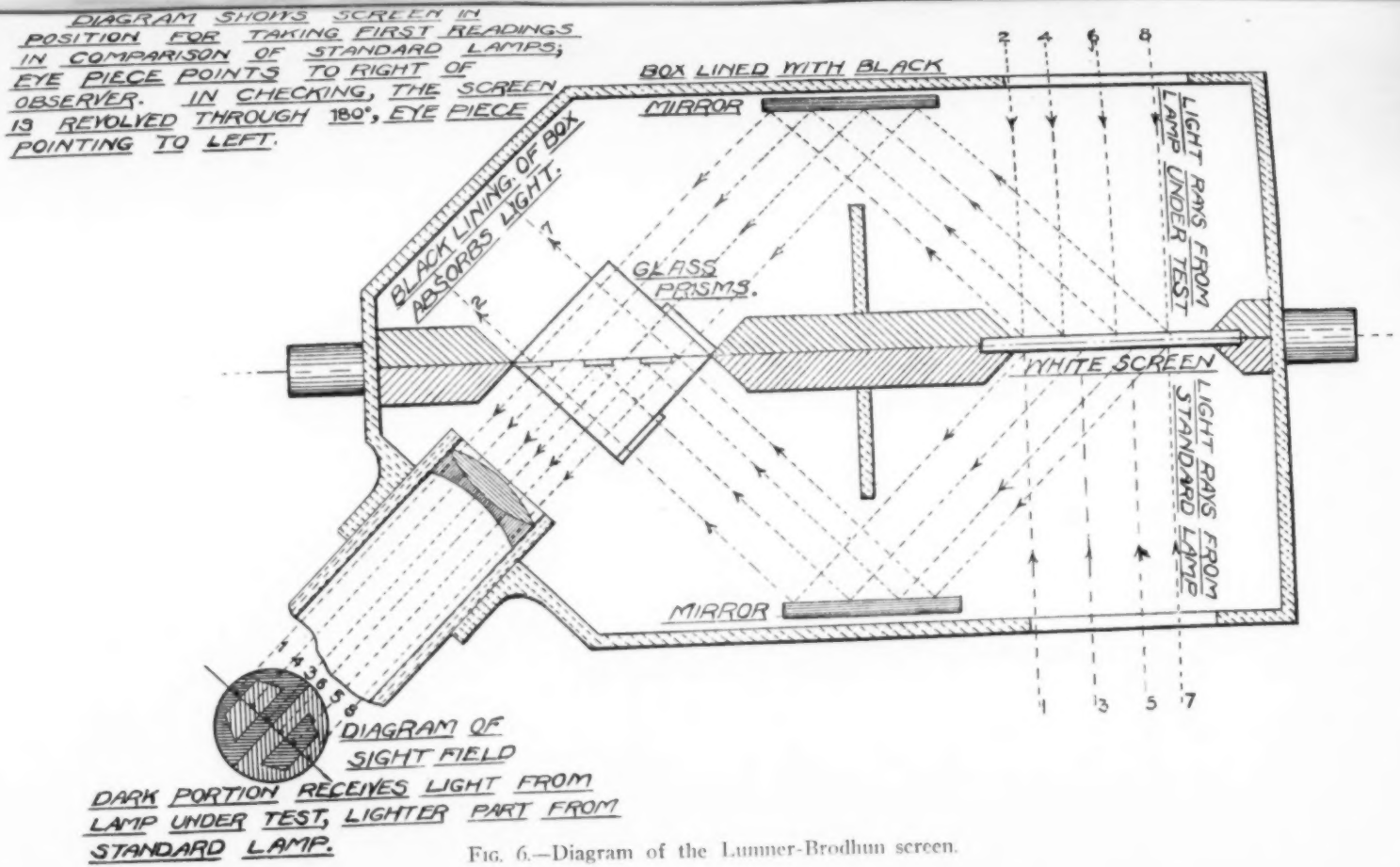
DIAGRAM SHOWS SCREEN IN POSITION FOR TAKING FIRST READINGS IN COMPARISON OF STANDARD LAMPS; EYE PIECE POINTS TO RIGHT OF OBSERVER. IN CHECKING, THE SCREEN IS REVOLVED THROUGH 180°, EYE PIECE POINTING TO LEFT.
BOX LINED WITH BLACK
MIRROR
BLACK LINING OF BOX ABSORBS LIGHT.
GLASS PRISMS.
WHITE SCREEN
LIGHT RAYS FROM LAMP UNDER TEST
LIGHT RAYS FROM STANDARD LAMP
MIRROR
1 3 5 7
2 4 6 8
DIAGRAM OF SIGHT FIELD
DARK PORTION RECEIVES LIGHT FROM LAMP UNDER TEST, LIGHTER PART FROM STANDARD LAMP.

Fig. 6.—Diagram of the Lummer-Brodhun screen.

is fixed by the circular scale so that the plane through its filament will be 60 degrees from that of the optical axis of the photometer. Its voltage, as determined in standardization and as recorded by the voltmeter, *G*, is kept constant for any fluctuation of the line voltage by the rheostat, *F*. The lamps under test are mounted consecutively in the socket, *L*, which is kept revolving at 180 r. p. m. by the motor, *E*, and the voltage of the test lamp is varied by the rheostat, *R*, until equal balance is shown on the screen, when the voltage as indicated by the voltmeter, *H*, and the current, as indicated by the ammeter, *J*, are read. To avoid cracking or scratching the bulbs by contact, which weakens the vacuum, all lamps are handled in the racks only after unpacking.

The number of lamps tested is governed by the specifications above cited.

In order that a representative lot of lamps be tested, the lamps tested are selected equally from all the barrels or packages in the shipment, except in case one or more barrels or packages contain lamps of mixed voltages; in that case the test lamps are so selected that the percentage of each voltage is the same percentage as the number tested is of the number represented by the test, care being taken that some lamps are selected from each barrel or package.

Each lamp is marked in ink on its label with a serial number. This identifies the lamp during the test and upon the records. Failures are recorded by a check mark in the proper column of the test record form opposite the test number of the lamp failing.

The mercury contacts on the rotating socket should be clean, well amalgamated, and have sufficient mercury in the cups to insure good contact. The rotating socket should be tried to see that it can be driven at 180 r. p. m. and that it will maintain that speed.

Care should be taken that all working parts of the Bunsen screen are clean and that the two sides are in exactly the same condition. Only a soft chamois cloth is used for cleaning the working parts and a soft camel's hair brush for dusting the screen. These directions apply to the care of the Lumner-Brodhun screen also. When either screen is perfectly clean the direct and reversed readings will be exactly the same. Great care must

be exercised in cleaning the Lummer-Brodhun screen to avoid injury to any of the delicate parts.

Before starting to test a voltmeter is checked daily with the laboratory standard voltmeter at the voltages at which it is to be used, and the photometer voltmeters calibrated to conform to it. These photometer voltmeters must be adjusted every time a voltage differing a few volts from that last used is to be read on them. Adjusting by means of a magnetic shunt obviates the necessity of correcting each reading as it is taken.

The ammeter which is to be used is calibrated daily by checking it with the laboratory standard ammeter.

Care should always be taken that no lamp is subjected to a voltage higher than its rated voltage. To accomplish this always have both photometer rheostats "all in" before starting a test.

In standardizing, since the laboratory tertiary standards are 16 c. p., for a lamp of any other candle-power the screen would be placed at that distance on the bar scale from the standard lamp which would accord with the law that the intensity of light varies inversely as the square of the distance; in standardizing a 5 c. p. lamp the screen would, therefore, be set at 6.4 inches on the scale bar from the lesser candle-power, or 53.6 inches from the standard 16 candle-power. The positions for the different types of lamps are, however, marked on the photometer bed, *A*.

There are two considerations of the foregoing test which deserve some passing explanation; they are the *mean horizontal candle-power* and the *standardization*. The first question is what is to be the relation of the filament of the test lamp to the optical axis of the photometer when the lamp is emitting its mean available candle-power. It is not a question as to the standard lamp because that lamp is standardized for the fixed 60-degree position and should obviously be so set.

Two candle-powers are recognized in lamp tests, one given out at the end of the filament, or end candle-power, the other given out at the side of the length of the filament, or horizontal candle-power. A lamp constructed with a filament running straight through would evidently have no end candle-power at all, and, in general, the end candle-power will be less than the horizontal for any type of filament. This suggests that a lamp be so installed in the ship as to emit its light at the side rather than at the

end and that, for overhead lighting, the lamp should be laid flat if the side illumination is to be lost in the particular location.

Whether the test lamp shall be set with its axis in continuation of the optical axis of the photometer, end on, or with its axis in, but perpendicular to, that optical axis, has been a mooted point; it is now the recognized practice to adopt the latter method as a better comparison with the usual and necessary practice as to gas flames, etc., and the horizontal candle-power method is very generally accepted.

The method of test of candle-power by fixing the plane of the filament at the best angle for the determination of a good mean is found not to be as fair to the lamp as the determination by rotating at a necessary speed, as the mean horizontal candle-power determined by the latter method is in excess of that for which a comparable mean could be measured for the same lamp when in the fixed position.

Another method of testing, by mean spherical candle-power, deserves no particular mention as it is practically the same in result as the mean horizontal.

The second question, standardization, is dependent upon the reliability of the official reference standards. The Equipment Department of the Navy Yard, New York, is in possession of 18 of the very best standard 16 c. p. lamps extant. These lamps were carefully constructed by the General Electric Company for the especial purpose and were selected as the best of the number of well-seasoned lamps so constructed. They have a loop (horseshoe) filament and operate at between 48 and 50 volts, taking from 1.18 to 1.2 amperes to produce 16 c. p. when at the 60-degree angle. The lamps were standardized by the Physikalish Technische Reichsanstalt, of Charlottenburg, Germany, in comparison with the Hefner Alteneck Amyl-acetate lamp. In determining the candle-power the ratio of the English Parliamentary Standard Candle of 46 millimeters (1.773 inches) flame height to the Hefner lamp is taken as 1.14 to 1.0.

The comparison was made both when revolving at 180 r. p. m. and when the plane of the filament was 60 degrees from that of the center line of the photometer, on the line marking the 60-degree position toward the disc.

The best nine lamps are used as primary standards and are marked P-1, P-2, etc. The remaining nine are the secondary

standards and are marked S-1, S-2, etc. From these standards 20 other lamps were standardized; they are known as the tertiary standards (marked T-1, T-2, etc.), and were made and selected for the purpose at the same time as, and are exactly like, the primary and secondary standards.

The standard lamps are handled by laboratorians only. Four primary, four secondary, and five tertiary standards are buried

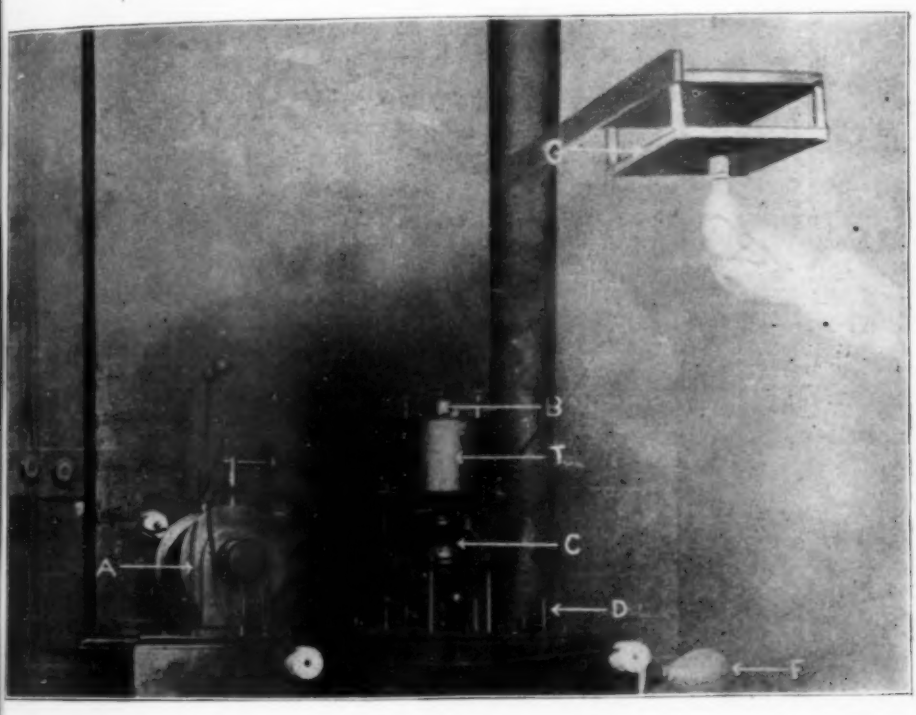

FIG. 7.—Apparatus for vacuum test.

in an air-tight box to avoid loss of reference standards in case of fire. The secondary standards are checked with the primary standards every six (6) months, January and July, and the tertiary with the secondary every month except when no lamps have been under test during that month. The Lummer-Brodhun screen is always used for these tests.

Whenever a lot of new lamps are to be tested one of the tertiary standard lamps is used as the working standard; a lamp taken

from the lot will not suffice as, not being properly seasoned, its candle-power will not remain constant. In order to give the same amount of use to each of the tertiary standards they are used in rotation.

The Vacuum Test.—The vacuum test is made after the photometer test. The vacuum tester is shown in Fig. 7, and the manner in which a lamp is held while testing.

The tester is a Will-young X-ray apparatus. The induction coil, *A*, has its primary connected to an interrupter which differs from the ordinary type in being rotary instead of vibratory. The interrupter, *B*, is attached to the shaft of a Lundell 1/12 h. p. motor, *C*, by which it is driven at a speed of 1500 r. p. m., making 75 breaks a second, or three per revolution; the breaks are made under water, the interrupter being enclosed by a copper tank, *T*, for the purpose. The reversing switch, *D*, is connected to the primary circuit; it changes the direction of the current in the primary coil and interlocks with the motor switch so that the latter cannot be turned off with the reversing switch left at *on* point.

The condenser is of the ordinary type and made up of tin foil and paraffined paper. One electrode of the secondary of the coil is connected to an insulated metal plate, *G*, and the other to both terminals of the lamp, *F*.

The X-ray machine is regulated to give a spark of about three-eighths of an inch in length for regular lamps; for lamps of 5 c. p. and below a ¼-inch spark is used. The spark gap should be rather less than more than this. The terminals are, after the machine is regulated, set at a greater distance apart so that no spark passes between them.

The lamp to be tested is then held in the hand, grasping it by the bulb, and its base brought into contact with the metal plate, *G*.

If the vacuum is very poor the lamp will glow all through *even before it touches the plate*. If it is better than this, but still not good, there will be a glow all through the lamp when its termals touch the plate.

If the vacuum is good enough there may still be a considerable amount of glow, but it will all appear on the *inside surface of the glass*, and not at all in the interior of the lamp.

The glow in the interior of the lamp in the case of a bad vacuum will be of a blue color, or, if the vacuum is very bad, of a

purple color. In the case of a good vacuum, when there is a glow upon the glass only, it will be blue if the bulb is made of lead glass, but of a green color if German glass is used. In the case of a good vacuum the glow on the glass is intermittent and only appears in patches or there may be no glow at all.

With a good vacuum while one hand holds the lamp to the plate the other hand may grasp the lamp, *F*, connected to the other terminal of the X-ray machine with impunity; while, if the vacuum is bad, a shock will be felt. The experiment is dangerous if the frequency is low.

The coil or inductorium test, while good, is not infallible. A lamp which shows a poor vacuum may, by being run very bright on the photometer for a minute or two, be made to show a good vacuum on the coil, no trace of any glow being perceptible. A clouded appearance of the glow, as if the interior were filled with steam, is a sure indication of a bad lamp whatever the color.

A lamp which, when run at rated voltage, shows blue is a bad lamp and requires no farther vacuum test.

The Life Test.—The life test is practically crucial as to filaments demonstrating the sufficiency of the construction by the test of endurance, the quality of the treating (flashing) by the amount of deposit on the interior surface of the bulb, and the integrity of the clamp under protracted heated conditions. The test also determines in a way the sufficiency of the vacuum, as with a poor vacuum the filament will soon burn out; but this particular fault would not be separable in a life test from poor construction of the filament.

The great problem of a life test is to keep the test lamps burning continuously at constant voltage over the interval of their useful life, that is, while their candle-power is reducing to 80 per cent of the initial rated candle-power. Even with the expedient of burning at 3.1 efficiency the test will still require from 15 to 20 days (360 to 450 hours), day in and day out. Automatic regulation enables us to obtain very reliable results.

The life test apparatus is shown in Fig. 8; it was constructed at the navy yard. There are six lamp banks, *A* (two are not shown): four banks are for lamps having the standard base (150 c. p., 32 c. p., and 16 c. p.) and can take 12 lamps each; a fifth bank can accommodate 48 1-candle-power instrument lamps, and a sixth bank, 48 5-candle-power instrument lamps. Each bank

has an adjustable resistance, by which the voltage of the bank can be adjusted to the voltage of the mains; hence, 80-, 110-, and 123-volt lamps can be tested at the same time. The difference in actual voltage of the lamps on the same bank for the same rated voltage are adjusted by inserting small pieces of resistance wire in series with the connection of the particular socket, the wiring

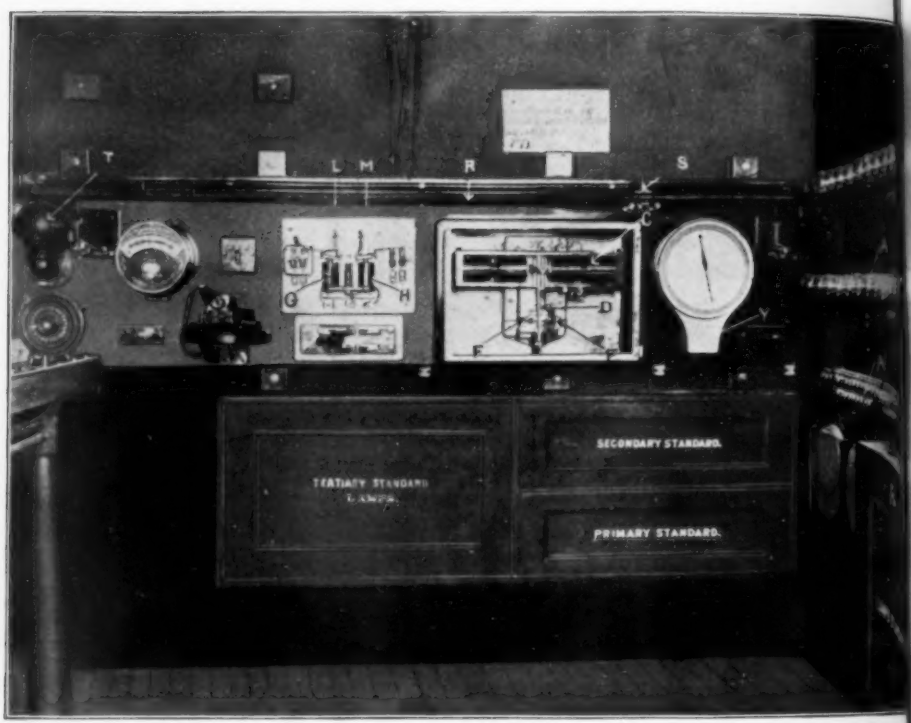

FIG. 8.—Compensating voltmeter and lamp banks.

being arranged to provide for it. These resistances give the lamps the voltage which produces an efficiency of 3.1 w. p. c. for each.

The voltage of the mains is kept constant by the automatic compensating voltmeter, *C*. The contact maker, *D*, is a long metal pointer which is pivoted at its upper end. At this pivot is fastened the armature of the electro-magnets and at such an angle with the main axis of the pointer that the armature will be

in the center line of the electro-magnets when the pointer is at its extreme throw to the left. The pointer is electrically connected to the current of the line through the circuits of the electro-magnets which are shunted off the main line. In its motion from side to side the contact maker, *D*, closes circuits at *E* and *F*, which send a current through either one or the other of the two solenoids, *G* and *H*, of a relay; these attract their armatures, *L*, *M*, to which are secured two springs carrying two carbon points each, to make the connection double pole. When these carbon points come in contact with two other carbons connected in the main line, the armature of the motor, *T*, is energized. The motor turns a screw bar on which is a slider, *S*, moving over the surface of a coil rheostat, *R*, having two coils in parallel, and which is placed in series with the main circuit. (The apparatus as reconstructed has four rheostats with four sliders.)

If the voltage of the line should get too low, a spring draws the pointer, *D*, to the right, making contact to the right; the solenoid, *G*, is energized, its armature is attracted and the carbon points make contact with those connected to the leads of the motor armature; the motor then moves the screw bar in that sense which will *reduce* the resistance in the rheostat, *R*. If the voltage of the line becomes too great the electro-magnets of the automatic voltmeter will attract their armature on the contact maker, *D*, against the tension of the spring, contact will be made to the left; the solenoid *H* will attract its armature, and the motor energizes to increase the resistance of the rheostat, *R*. The reversal of the motor is assured by separately exciting its field by shunts from the mains.

At *V* is a Bristol recording voltmeter; a clockwork mechanism revolves a card marked on its outer edge in hours for 24 hours. The voltmeter pointer of the instrument presses on this paper, tracing a line in ink; volts are measured radially along the curves from the center. This voltmeter keeps an accurate record of the action of the automatic voltmeter.

Although this automatic apparatus is connected for 8 hours of the day on a power circuit, whose voltage is much disturbed by throwing motors on and off, its performs its duty well under the adverse circumstances. From 5 p. m. to 8 a. m. the line is fed by the comparatively steady source of storage batteries. The compensating voltmeter has during this interval to compensate

for the small decrease of about one-half volt only; this ideal condition for the working of the compensating voltmeter is not available during the day owing to the necessity of charging the storage batteries. The sensibility of the compensating apparatus is such that it will operate on a change of two-tenths volt in either direction, insuring the great desideratum of a life test, steady voltage.

When selected for life test each lamp is given a serial or reference number, which is marked on the label. The number is also scratched on the brass base. This number identifies the lamp upon the records and throughout the test.

One lamp of each lot is laid aside to be used at the end of the test for comparing the blackening upon the inside of the bulbs.

Each lamp put on life test is first tested for vacuum.

The voltage of the lamps selected for life test is brought to that value at which the lamp burns at 3.1 watts per mean horizontal candle-power. Throughout the life test each lamp is burned at the particular voltage which was required to give 3.1 w. p. c. initially.

The voltage to be used for an efficiency of 3.1 w. p. c. is obtained experimentally; it can be calculated approximately by the compound proportion, the total watts at the efficiency of the design as determined by the photometer test compared with the total watts at 3.1 w. p. c., the rated candle-power compared with that at 3.1 w. p. c., and the voltage as determined by the photometer test compared with the unkown, or that to be maintained for an efficiency at 3.1 w. p. c. In practice the required voltage is picked out from a previously constructed curve in per cent, but the curve must be made on a large scale to obtain the fractions of per cent incident to variations of one-tenth of a volt.

As before cited, photometer tests are made after a run of 25, 50, 75, and 100 hours and after every 100 hours thereafter until the candle-power has decreased to 80 per cent of its initial candle-power. The periods should be kept as close to 25, 50, 75, and 100 hours as possible. In case any run exceeds 25, 50, 75, or 100 hours as the case may be, the next period is to be that much shorter so that no time accumulates. The average value of the candle-hour performance of the lamps subjected to life test must not be less than the amount shown in column 8, Table 2.

Adjust the compensating voltmeter and calibrate all other

apparatus to be used during the life test. Be sure that the adjustment and operation is correct and make a trial run on dummy lamps for a day and a night before starting the test run. This will remove the variation due to heating of the coils of the compensating voltmeter and other apparatus. When a lamp burns out ascertain if the difficulty is with the filament of the lamp before removing it from the rack. Note and record the time at which the lamp burned out, and if possible the cause. Save the lamp for a print to show blackening and location of defect in filament.

A new chart is dated and put in the Bristol recording voltmeter each day; the clock attachment being wound up at the same time. From time to time (preferably once a day) the recording voltmeter is compared with the standards. By means of an auxiliary resistance in series with the recording instrument, its calibration can be changed to conform with that of the standard when necessary.

As charts are taken off they are again dated and upon them a note is entered indicating the lamps burning during the time represented by the record.

The Bristol instrument is especially intended to record, by an irregularity in the curve, the elapsed time of any break in the circuit such as would be caused by a fuse blowing out or the operation of any one of the automatic devices for opening the circuit.

In case a lamp burns out during the night the potential rises owing to the change in current in the resistance coils, and a small irregularity will be noticed on the line of the Bristol recording voltmeter which records the exact time of the burning out.

The voltage of the lamps under test should be often checked and adjustment made upon the rheostats when necessary.

The lamp banks are made up of spring sockets so that the life test can be run with lamp filaments at any horizontal angle. As the test is now made the loop of the filament lays flat so that the drooping effect may be observed. Spring sockets also give a means of testing for the strength of cementing of the base of a lamp which must stand screwing up hard without breaking the base away from the bulb.

Heating of the clamp where the filament joins the platinum

leading-in wires is a defect which is to be carefully watched during a life test.

The charts should be kept to constitute a complete check upon the "Time Log." The entries in the time log should be made each morning and evening and should contain notes of the condition of the test at the time and also a record of the times of opening and closing the circuit. The log is intended to be a record of the time the lamps have burned. If the circuit should be opened during the night the entry would be made from the chart of the recording voltmeter, but under no other circumstances should the voltmeter chart be used for making entries in the time log.

Voltmeters are kept in the lamp circuit during the entire run. Besides this, the photometer instruments consisting of voltmeter and ammeter are reserved for this work only. These instruments are calibrated at regular intervals and always before taking the photometer test at the 25, 50, 75, and 100 hour intervals.

Method of Recording and Reporting Tests.

As the photometer tests are made the data are recorded. Each of the separate tests is averaged and entered up in the resumé. The resumé is intended to show the results of the test and is made up to represent the average of the lot of lamps under test.

Lamps.—The test is started with a certain number of lamps, and as these burn out the actual number left burning is recorded as indicated.

Average c. p.—The initial is taken as 100 per cent, and the actual is expressed in terms of it. The candle-power is the mean horizontal candle-power as measured by the photometer while the lamp rotates at 180 r. p. m.

Average w. p. c.—(Average watts per candle when running at the current and voltage determined by photometer.) The initial is taken as 100 per cent and the actual is expressed in terms of it.

The candle-hour performance of the lamps is considered as the sum of the candle hours given during each of the observed intervals, and up to that time when the lamp shall have burned out or shall have fallen to 80 per cent of its test candle-power.

Resistance.—The initial is taken at 100 per cent and is from

the readings of current and voltage of lamps during the preliminary photometer run. The actual is computed from the data recorded.

From the resumé data is taken to plot the following curves (Fig. 9):

(a) With time and c. p. (average) as co-ordinates.

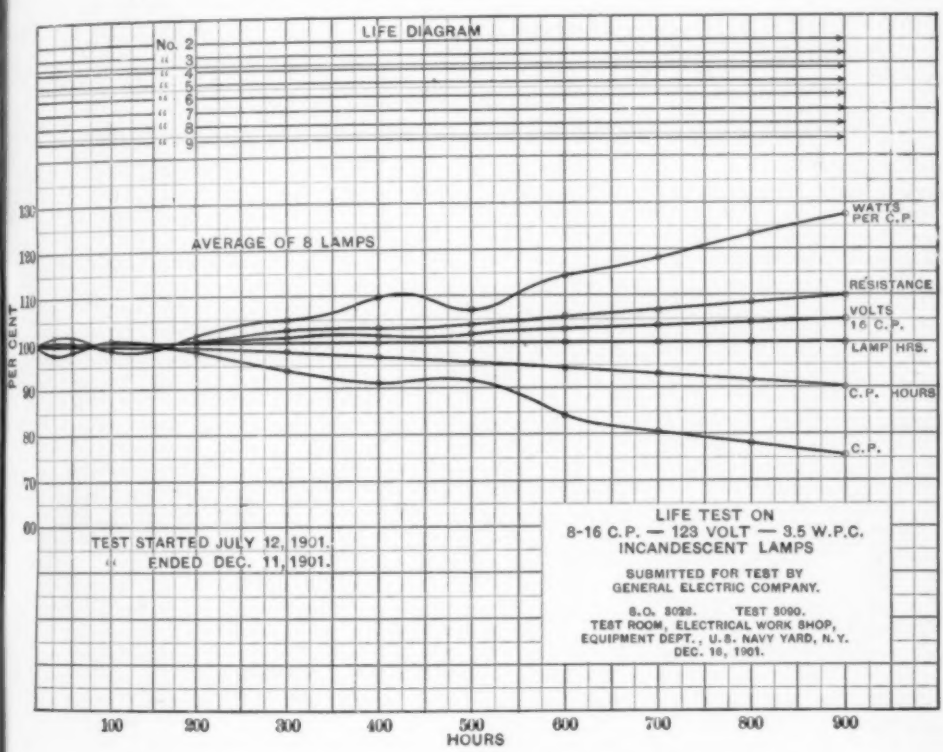

FIG. 9.—Curves of performance on life test.

(b) With time and volts per rated c. p. co-ordinates.

(c) With time and w. p. c. (average) co-ordinates.

(d) With time and resistance (average) co-ordinates.

(e) With time and lamp hours (total) co-ordinates.

(f) With time and c. p. hours (total) co-ordinates.

The length of time a lamp burns is represented by the length of a line drawn parallel to the time co-ordinate, one time to represent one lamp.

It will be noted in Fig. 9 that the candle-power developed for the first 50 hours or so is greater than that for which the lamp is designed; this result is characteristic of all life tests and is the occasion for the prescription of 3 per cent in specifications.

After completion of the test all the lamps are mounted (or a selected representative number) with the one which was laid aside at the start, in receptacles on a block and a photograph made through them, preferably using an arc or a search-light for a source of light as the definition from this light is sharper and the defects in the filament and glass are better shown.

The lamp that was set aside should be mounted in the center and those that ran the longest disposed equally on each side; that that burned out first being at the ends.

The Target Diagram.—The Target, or "shotgun," diagram, when used in connection with the curves of Fig. 9, shows at a glance the results of the photometer and life tests of the test lamps. The diagram, Fig. 10, is constructed with candle-power and total watts as the co-ordinates forming a rectangle. The diagonals are the efficiency limits based on a mean rating of 3.5 w. p. c. As the upper left-hand and lower right-hand triangles are outside the prescribed limits the diagram represented by the contour line is really that used for reference.

The upper large black dot represents the mean for all the lamps as tested by photometer before the life test.

Each lamp of the test lot is plotted on the diagram by its serial test number in accordance with the results obtained on photometer test, and again from photometer results after life test; the same lamp in each case is then connected on the diagram by a dotted line to show individual performance, the slopes of these lines should evidently be the same. A mean position is also plotted which is derived from results for all the lamps, as in the case of the photometer test. This mean shows the general characteristics of the whole test lot submitted and also the particular feature in which the lot is lacking.

In order to obtain intelligent results from the diagram care should be taken *not to construct it from a selected lot of lamps sent by a manufacturer;* the test lot of the actual delivery is the only good guide of performance, as selected lamps could be so picked out as to show quite different results from those determined by the test of the delivery.

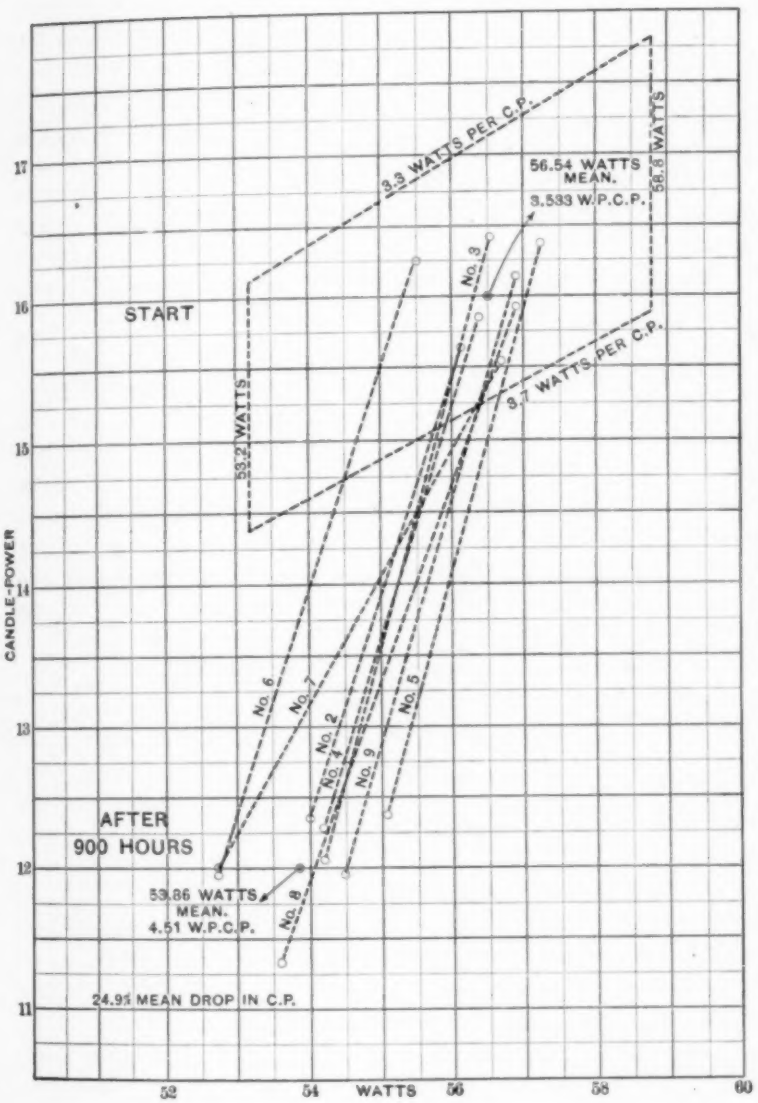

FIG. 10.—The target diagram.

CHAPTER II.

ARC LAMPS AND SEARCH-LIGHTS.

The feature of arc lamp lighting is the great amount of light emitted from a single fixture, affording a decided advantage when large spaces are to be lighted whose height, or general use, renders the total required installation of incandescent lights difficult, insufficient and expensive in comparison; the spaces usually so lighted are fire rooms and engine rooms, and the arc lamps furnished a ship are on the basis of one lamp for each fire room and one lamp forward and abaft each main engine.

Arc lamps give very efficient lighting over coal barges when taking coal at night.

The type of arc lamp heretofore supplied, and known as the "miniature arc lamp," has been superseded by a commercial type commonly used for interior lighting and known as the "parallel rod, edgewise wound, direct current, enclosed arc" lamp. It is shown in Fig. 11. It operates at 4½ amperes and is adjustable for 80, 110, and 125 volts.

The advantages of the enclosed arc type over the open arc are: first, it can be run off the mains in multiple similarly to an incandescent lamp; second, it requires less trimming (putting in new carbons) for, while an open arc lamp will require the renewal of at least its positive carbon after burning for but from 12 to 14 hours, that of the enclosed arc will not require renewal under from 100 to 175 hours. The carbons of the lamp shown in Fig. 11, having a closed-base enclosing globe, will burn from 125 to 150 hours.

The mechanism is protected from dust, etc., by a bronzed sheet copper casing (Fig. 11), which is attached to the lower inner edge of the cap (at the top) by hook bayonet joints and held by set screws. To the lower edge of the casing is secured the clear glass outer globe which is protected by a guard, or cage, also secured to the casing. By loosening the thumb screws which hold the casing to the cap, and disengaging the bayonet joint, the casing together with guard and globe can be taken off clear of the inner (enclosing) globe and the mechanism.

The enclosing globe is of opalescent glass, is closed at the bottom and is held to the disc framing of the mechanism by

screws under the globe flange. Its office is to exclude air from the carbons, having the general effect of increasing the voltage required to maintain the arc; for, while open arcs are generally

FIG. 11.

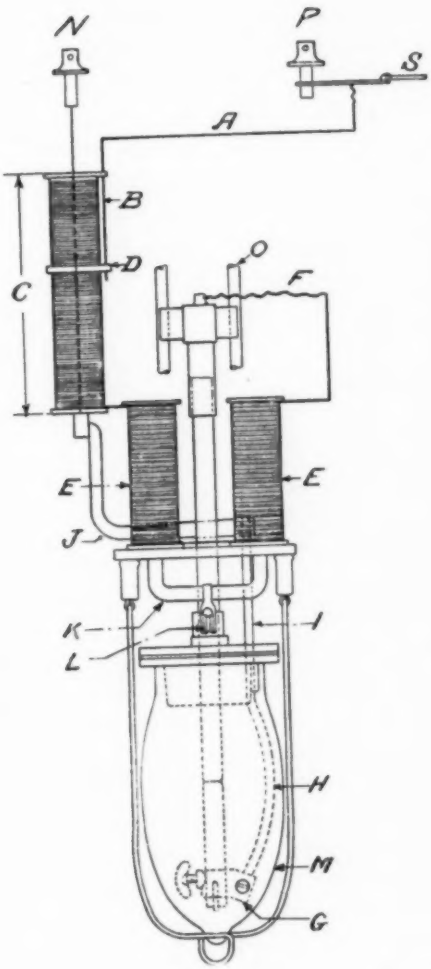

FIG. 12.

FIG. 11.—Arc lamp, Form 12, General Electric Company.
FIG. 12.—Mechanism of the Form 12 arc lamp.

maintained at approximately 50 volts, the enclosed arc requires an average of approximately 85 volts; this, of course, represents

a loss of energy in comparison, for as two lamps in series could be run on a 110-volt circuit with a loss of but 60 watts for both, the enclosed arc system represents a loss of 180 watts for the single lamp; the convenience of branching off the enclosed arc type in multiple, its softer light and the material reduction in labor of replacing carbons has, however, caused it to largely supersede the open arc for street lighting and very generally for interiors.

The mechanism is shown in Fig. 12.

The current entering the electrode *P* reaches the slack positive wire *A* through the switch *S;* this wire is connected to a brass rod *B* which runs in a guide hole of the top of the spool of the rheostat *C;* on this rheostat is a ring or movable contact *D*, which can be set at any proper place on the rheostat *C* necessary to give that voltage which will give best working of the lamp; its effect is to connect the positive wire to that point of the resistance which will cut down the potential of the line, between the positive terminal *P* and the negative terminal *N*, to that potential at which the lamp is to operate; it is essential that the ring *D* shall be adjusted and set by the lamp makers in conformity with the voltage of the customer's supply line, and that it shall not be changed thereafter except by experts.

The rheostat *C* is made of bare, flat wire or ribbon and is wound on edge, each layer being insulated by a non-inflammable material; this, and the similar construction of the magnet windings, occasions the designation " edgewise wound."

After passing through the flat windings of the rheostat *C*, below the movable contact *D*, the current passes to the windings of the two electro-magnets *E*, and thence by a slack wire *F* to the holder of the positive (upper) carbon *I*. The current then passes (by contact, or arc) to the negative carbon, thence to the clamp *G* and metal frame *H*, which holds the negative carbon, to a brass rod *I*, extending up back of the magnets, to a curved cross rod *J* that leads under the center of the rheostat *C*. From this point a straight connection leads to the negative terminal clear of, and through the center of, the rheostat.

The operation is: The entering current through *P*, *A*, *D*, and the rheostat *C*—finally reaching *N*—energizes the two electro-magnets *E;* these magnets draw up a horseshoe-shaped plunger *K*, which has a holder with bell-crank clamp *L;* this clamp grips

the positive carbon as long as *K* is attracted into the magnet core and only releases it when resting on the disc frame which carries the enclosing globe *M*. The action of the plunger thus strikes the arc and starts the lamp. As the carbons burn away, the resistance across the arc increases, decreasing the current in the windings of the electro-magnets and hence the lifting power of those magnets; the resulting effect is that the positive carbon is lowered until the magnets hold it in proper relation to the resistance; that is, the magnets automatically adjust the distance to be maintained between the two carbons for steady burning and steady light. The guide rods *O* are in reality attached to the plunger *K* through the center of the electro-magnets, thus centering the plunger and keeping the axes of the positive and negative carbons in line; they are connected to a small dash pot (not shown) containing air only, which cushions any shock which might occur from a sudden failure of the current in the magnets and the consequent dropping of the plunger *K*.

When the switch *S* is opened the positive carbon descends slowly until the clamp *L* strikes the disc frame; the clamp then releases the positive carbon, which descends to rest on the negative, making an actual contact which is the necessary condition for the next starting up.

General Directions.—Only high grade solid carbons should be used in the lamp; the dimensions of the positive are 12 x ½ inch, and of the negative, 5 x ½ inch.

After unpacking a lamp, remove its casing, which is supported at the top by a bayonet joint. Loosen the thumb screw at the side of the top cap, raise the casing slightly and turn it to the left until it can be lowered. Take out all wedges and packing from the mechanism. Brush out any dust that may have accumulated, and examine the mechanism for loosened parts. Be sure that the movable parts work freely. Then replace the casing and the lamp will be ready for operation.

The lamps are usually installed on board ship by connecting to a switch and receptacle through a length of double conductor, plain, and the ordinary attachment plug; the use of the switch *S* (Fig. 12) is therefore not necessary; the adjoining junction box contains the fuse for the lead. *The binding post on the switch side of the lamp is positive and the attachment plug must be so entered into the clip of the receptacle as to insure this*

polarity; this is best accomplished by marking the contacts of the plug plus and minus and scribing the corresponding mark on the receptacle; if there is doubt as to which side is positive, insert the plug into the receptacle, let the lamp burn a few minutes and then switch off; the upper (positive) carbon should remain red hot longer than the lower (negative)—if the lower carbon remains red hot longer, reverse the plug.

The lamp should never be used without the enclosing globe, which excludes air from the arc. Closed base enclosing globes must rest squarely against the machined surface of the stationary cap. The number of hours the lamp will burn at one trimming depends largely upon keeping the globe tight and excluding the air.

As carbons vary somewhat in diameter, use only those of the dimensions specified. They should pass freely through the enclosing globe cap, for any friction at this point will prevent the proper operation of the lamp. The carbons must be smooth—sandpaper them if necessary, to remove small bunches of blisters.

To insure proper electrical connection to the positive carbon, it must be well inserted in the spring carbon-holder. Inserting carbons is facilitated by bevelling their ends. Better light will be obtained if the enclosing globe is cleaned thoroughly at each trimming.

Carbons are usually supplied in 12-inch lengths, the negative carbon being advantageously derived from the remainder of the positive after some use. Spare carbons should be stowed in moisture proof tins and care should be taken that they do not absorb oil.

Never use oil in the dash pot or on any part of the mechanism.

Inspection of Arc Lamps.

Mechanical Construction.—The general workmanship in appearance, strength and adequate sufficiency of the various parts and the mechanism is rather a matter of comparison for the many details, comprising in each lamp some 36 parts apart from assembling machine screws. Principal points are as follows:

1. The overall dimensions from inner edge of top of hook to extreme base of guard not to exceed 27½ inches; maximum allowable width at any part 8½ inches; maximum weight, 23 pounds.

The dimensions should be a minimum on account of the character of the locations for which the type of lamp is intended; the locations forward and abaft main engines is an especially contracted space; the limiting dimensions are those which are readily met by commercial types of construction.

2. The design of the lamp and its operating parts must be such as to adapt it for use in engine and fire rooms of naval vessels.

This specification is to be considered with reference to the effect of the rolling, pitching and vibration of the vessel; the capability of continued operation when subjected to the moisture, dirt and oil incident to engine and fire rooms; and its capability of continued operation when exposed to weather, an experience to which the lamp will be subjected when used for lighting over coal barges when working at night. The determination of these matters rests mainly on the tightness of the outer and enclosing globe and the close assembly of the casing.

3. The top of the case is to be in one piece to form a watershed, and to have an insulated hook for suspension.

The cap is usually so designed, note particularly that the suspension hook is insulated.

4. The case enclosing the operating mechanism shall be susceptible of ready removal, and replacement.

The desirable feature should go farther than this and include the removal and replacement of the casing, outer globe and guard without disassembly of these parts; the proper method is explained in the description. This is not to be construed as meaning that the casing must be removed when the carbons are to be renewed; this is provided for in the next item.

5. To be fitted with a strong guard, bronze finish, capable of ready removal without the use of tools, and fitted with chains which will permit the dropping of the guard far enough below the enclosing globe that this globe can be conveniently removed in trimming.

6. The outer globe must be capable of being removed with the guard.

This does not preclude that they shall be separate, that is, it is not necessary that they be attached to the same ring with hinge design, etc. The globe requires to be separated for the cleaning necessary, at least, whenever the lamp is trimmed.

7. The lamp is to be designed to take at least a 10-inch positive carbon. The usual carbon is 12-inch.

8. The outer and enclosing globe are to conform to the official drawing, but are acceptable if interchangeable with the design of that drawing.

The enclosing globe is specified to be of the light opal type; it is advisable that the opalescence be not too obstructive of the candle-power emissivity of the lamp.

9. Resistance material of the rheostat must be non-corrosive; the mounting must insure against sagging from excessive heating, crossed grounds or short circuits. Means for readily adjusting the resistance must be provided.

The resistance is designed for adjustment over the range of 80, 110, and 125 volts of the supply line, but is not intended to be altered after once being adjusted for the voltage used in the particular ship.

10. Switches are not required, but if they are fitted they must be of the self-contained lever type, and accessible by use of a stick from the deck below.

A ring or hook must be a part of the design, to afford a means of suspension. Terminals for the line are to be fitted at the top and marked for polarity.

Electrical Qualifications and Test.—The lamp after unpacking and examination as to mechanical matters is connected up to a 80, 110, or 125 volt circuit, as the particular delivery may be specified, and the connections are traced to determine that the polarity as marked on the terminals is that of the connections. The cold drop of the magnet windings (for heat rise, see test of Generators) is then taken and the temperature of the resistance and casing is taken by thermometers, covering the bulbs with cotton. The current is then switched in and the lamp run for four hours, when the hot drop of the magnet windings is taken, and the temperature of the resistance and casing as before. The temperature of the air is noted half-hourly during test.

The permissible heat rise of the magnet windings is 60 degrees centigrade. There is no restriction as to the heat of the resistance or casing. (The low limit of 60 degrees is necessitated by the hot locations in which the lamp is to be used.)

2. While still hot a high potential test of 1000 volts (see test of Generating Sets) is made for one minute between the current

carrying parts and the frame; these include the lead from the positive terminal; the windings of the resistance; the winding of the magnets; positive carbon holder; negative carbon holder and frame and rod attachment leading to the connection at the base of the resistance; and the negative lead.

3. Test is then made of the adaptability of the resistance for adjustment for 80, 110, and 125-volt circuits by adjusting the movable contact on the resistance; the greater the voltage of the supply the greater the resistance to be introduced, and the higher the contact must be clamped on the rheostat. As lamp constructions differ somewhat the point at which, for a given voltage in line supply, the lamp operates best must be selected; lowering the contact clip increases the arc voltage.

4. During the four hour run an ammeter is kept in the lamp circuit and the operation of the current regulation, by the magnets noted. The observations should be frequent and the current regulation must be within five per cent.

5. Observations must be made during the four-hour test that the arc is steady and free of jump and flaming; the current variations (four above) are particularly to be noted if jump and flaming occurs (it is, however, more a matter of quality of carbons than of lamp operation).

6. A life test—a test of the carbons—is next made, the new carbons being allowed to burn continuously until the positive carbon is consumed. Tests usually show about 130 hours. General observations of the operation of the lamp are made during this interval.

7. The lamp must automatically cut the lamp out of circuit when the carbons are consumed.

If a life test is not made, this is tested by putting in a short positive carbon, and running the lamp until the carbon burns away.

Search-Lights.

The varieties of projector usually met with in the service are of the manufacture of the General Electric Company or of the Schuckert Company. The sizes, rated by diameter of mirror, are 13-inch, 18-inch, 24-inch, and 30-inch; two 36-inch have been in use, and one 60-inch size has been installed.

The varieties (General Electric and Schuckert) have much in common, though differing in details; as a comparison in service

experience, preference is often given to the General Electric Company's type of lamp on account of its good service and simplicity; and to the Schuckert Company's drum, or barrel, by reason of the opportunity of closure of the front of its drum by a shutter, or "Iris Blind," a convenient and advantageous arrangement for search-light exercise, as the focusing and adjustments may be made ready before the signal for exercise; also, at the expiration, the light can be masked and then lumed off without showing the glow; another advantage for navigating purposes is the facility of masking or using the light as required without delays incident to focusing, switching, etc. This is especially an advantage in torpedo-boat destroyers whose search-light must be placed low down, and whose use has a blinding effect on the officer at the conn, whether on the bridge or near the wheel.

[NOTE 3.—The General Electric Company has recently designed a shutter. It consists essentially of radial rods across the aperture of the drum to which light blades are attached on each side: the rods move together through gearing throwing the plane of the blades parallel with the beam when open: the device makes good closure against escape of light when the blades are across the beam.]

General Electric Company's Projector.

There are two types of this projector manufactured by the General Electric Company, viz.: the "Electrical Control" and the "Hand Control."

Both types are alike in outward appearance, but the former type in addition to the usual electrical connections and training mechanism, contains two shunt motors, each with their train of gears. This type, in addition, is provided with a controller, controller receptacle and a flexible cable to connect the controller to the receptacle. The controller, motors, etc., however, are not now generally installed. The 30-inch size, fitted for electrical control, is shown in Fig. 13.

[NOTE 4.—The electrically controlled projector, by reason of its convenient operation from advantageous locations for the operator and especially when the projector is installed in tops, is probably again to be introduced: the difficulties occasioning its removal from service were with the controller, from burning out and corrosion of the enclosed resistances, but incident to the lack of care on the part of personnel rather than to general inherent defects, the principal of which was that the interior was not well water-tighted; in the newer types of controller the defect has been remedied.]

The projector consists essentially of a base, fork, drum, mirror, obturator and magnet, automatic and hand feed lamp.

The base consists of a casting drilled at the bottom to bolt

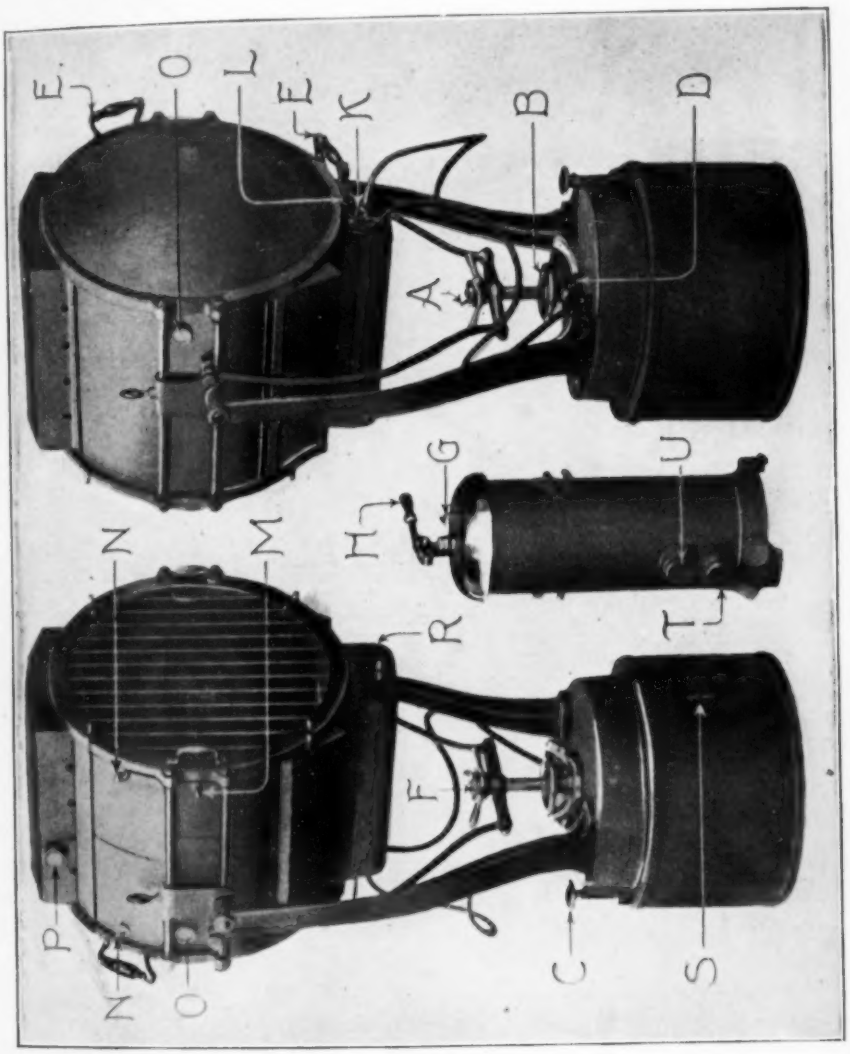

FIG. 13.—30-inch projector, General Electric Company.

to the deck and to receive the line wires, which wires connect to the lower terminal of a double-pole switch secured to the base; the upper surface of the base has a track ring for the

fork and drum to revolve upon, and to it are secured two insulated plungers with springs which act as conductors for the two leads which connect to the upper terminals of the double-pole switch.

The fork which supports the drum is composed of three castings; two arms and a turntable.

The upper end of the fork is fitted with bearings in which the drum trunnions work. The lower ends of the fork are bolted to the turntable. On the underside of the turntable the rollers are secured, which bear on the tracks of the base, and spring plungers in the base make electrical connection to two contact rings on the under side of the top of the turntable. From each of the contact rings a wire cable is led up to the lamp, and is secured midway, on the inner side of each arm of the fork by a brass clamp (see Fig. 13). The turntable of the electrically (changeable to hand-control) controlled projector contains a spindle surmounted by a cross-head with a special locking device of which: *A* is a hand star wheel for slow vertical movement; *B* is a wheel for throwing out a split nut, and is used for connecting or disconnecting the drum from the base mechanism; *D* is a hand star wheel for clamping the turntable to the center pin for engaging the electrical control. In the turntable of the projector having hand control only, all the gearing is omitted and only the hand star nut for clamping the horizontal movement is retained; the vertical movement being controlled by a hand star wheel on one of the arms of the fork and a quadrant fitted to one of the trunnions on the drum.

The drum consists of a cylinder, ventilators, mirror, front door frames, back cover and handles.

The cylinder is of sheet metal provided with three ventilators, two on the lower part of the drum to admit air; and one on top of the drum to allow the hot air to escape, and being so designed as to prevent entrance of wind and rain, or the escape and discovery of light; if to be located within 30 feet of the compass, the metal of the barrel and the securing rods should be specified to be of a non-magnetizable metal; experience in service shows this to be mandatory.

On one side of the upper ventilators is a focussing peep sight *P*, fitted with a lens and an enameled glass plate; on the latter the image of the carbons is reflected when the lamp is in operation and focus. A colored peep sight *O* is situated on each

side of the drum, which permits of viewing the arc without dazzling the eye.

A trunnion is secured on each side of the drum, and two eye bolts, shown, one on each side, are installed on the trunnion blocks to facilitate transportation.

The mirror frame is of brass, lined with asbestos, and is fitted at the back with equally spaced springs which hold the mirror in place, allow for expansion due to heating and provide for flexibility under shock of concussion. It is secured to one end of the drum and protection to the frame and mirror against mechanical injury is provided by a metal cover secured to the barrel.

The mirror is of glass ground to parabolic curvature, silvered on the back, the silvering being protected by a close covering of hard paint. The mirror frame is designed to take either Mangin or parabolic mirrors; both types are in use, but for some time past the practice has been to use the parabolic mirror only, it having the advantage of less noticeable, and therefore confusing penumbra as compared with concave mirror types, and greater effective aperture as compared with the Mangin; its distinct *apparent* advantage (as compared with the concave mirror) is that it lights up the foreground better and, as we are accustomed to outlining objects by their surroundings, the target is brought out with more sharpness and distinctness of outline.

The drum contains the mirror, obturator, drum slide contacts and the horizontal lamp. It has two handles *E* which serve to facilitate its manipulation when rapidity of movement is required. Two doors, *M* and *N*, are fitted to afford access to the carbons and the interior generally.

Front Door.—The opening of the barrel is closed by a door consisting of a ring having two handles (shown) and glazed with strips of plate glass. The use of the strips is more convenient and is more economical in affording a readier means of renewal after breakage by concussion, etc., than would be practicable for a solid pane.

The obturator, Fig. 14 (colloquially "shutter" but from which it should be distinguished), is suspended by a bracket as near to the arc as possible. It consists of an electro-magnet (magnetized by the current flowing through the carbons) and two semicircular brass shutters whose outer edges are hinged

to a bracket; a clamp serves to hold the shutters in position when closed. The object of the obturator is to cut off those rays of light which would otherwise proceed in a cone directly from the arc without being reflected by the mirror into a parallel beam. The magnet consists of a broken ring of soft iron, curved to surround the arc on all sides except the top; its office is to counteract the tendency of the arc to force upward—thus burning away the carbon at the top and forming an imperfect and inefficient crater—a tendency which is created by the hot air currents rising through the barrel. The magnet can be rotated on its horizontal axis, this device contemplating its use to align the arc should it tend to the side as well as the top, a condition sometimes arising from imperfection in the carbons.

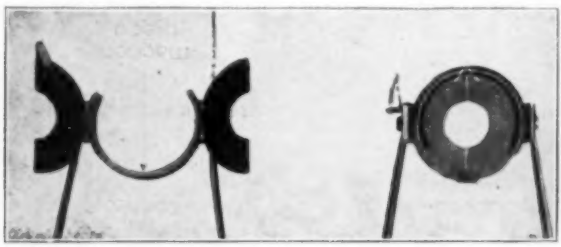

FIG. 14.—Obturator and magnet.

The drum slide contacts are secured to the inner lower part of the drum and to these contacts the cables leading from the contact rings are connected.

The controller, Fig. 13, is a sheet brass cylindrical cover attached to a composition base, with handles at the side for transportation. The latest type is much shorter than that of the figure and is fitted to be mounted on a bracket, or as convenient. Near the base is a coupling *T* fitted with recurved springs for electrical connection to the coupling attached to the controller cable. The resistance coils are in the interior of the case and ventilation is afforded around the rim of the cap. The controller (and hence the motors in the base of the projector) can be thrown in and out of circuit by the switch *G*. The handle *H* has a vertical plunger which makes contact with the motor supply lines (*G* being closed) to accomplish elevation and depression of the barrel and its motion to the right and left; the

device admits of simultaneous operation of elevation combined with a motion to the right or to the left as desired, or of depres-

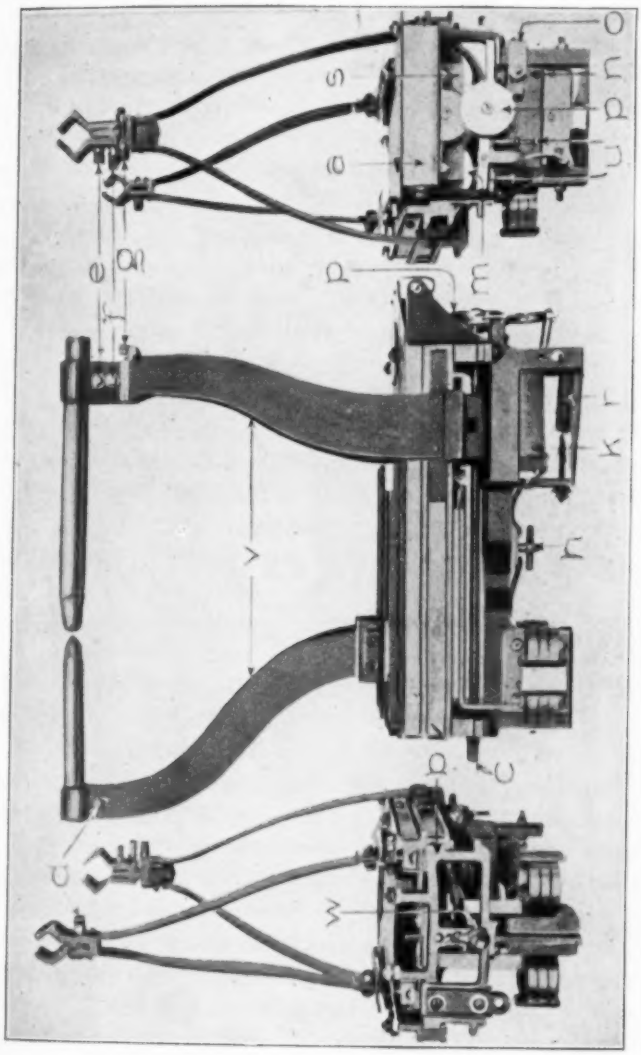

FIG. 15.—Lamp for 30-inch projector, General Electric Company.

sion combined with a motion to right or to the left; to elevate, the handle is raised; to depress it is pushed down; to move the barrel to the right the handle is moved to the operator's right, to

move to the left, to the operator's left; to operate vertically and in azimuth at the same time, first move the handle for elevation (or depression) and, holding it in that position, move to the right or left; releasing the handle for any position attained leaves the barrel pointing in that position. The maximum permissible elevation is usually 40 degrees, the maximum depression 20 degrees; a train of the complete circle is practicable. The tube *U* just above that for the controller cable is capped and contains the fuse for the supply line of the controller.

The lamp, Fig. 15, is of the horizontal, automatic, ratchet feed focussing, type; it is remarkably compact, simple, and efficient in throwing the greatest practicable amount of effective light on the mirror. The obturator cuts off the direct rays and the magnet centers the crater to the center line of the mirror. The carbon carriers are designed for vertical and horizontal adjustment of the carbons; the automatic feed controls the crater at the focus until the carbons are consumed. The principal parts are described in connection with the operation of the lamp under automatic feed, as follows:

When the main switch *S* (Fig. 13) is closed, the current enters by the positive connection to the insulated plunger on the inner top of the base, thence to the contact ring within the turntable, and by the positive wire up to the drum slide contact within the drum; before closing this switch the automatic feed switch *h* (Fig. 15) must be closed, and the carbons set about one-eighth inch apart by a socket wrench shipped on the square post *c* of the screw bar.

The main current enters the lamp by the positive contact spring (shown in three leaves and a contact plate below *c*), insulated from the frame, which is connected to the winding of the series, or striking arc, magnet *m*. Since, on closing the main switch, no current is passing, the dead resistance of the rheostat has no effect in cutting down the voltage to that required for usual operation of the arc; and, the resistance of separation of the carbons, one-eighth inch, being small, the voltage across the carbons at the instant of closing the main switch is approximately that at the switchboard, hence the striking arc magnet receives a large excess current, attracts its armature, which (being attached to the upper screw bar) moves the carbon-holder, forming ("striking") the arc; the arc having been struck, the dead re-

sistance of the rheostat—on passage of the current—cuts down the voltage to the operating voltage of the arc, about 50 volts, which voltage value is insufficient to maintain the attraction of the striking arc magnet for its armature; the armature is released, and the lamp thereafter controls the length of the arc by the shunt feed; the release of the armature of the striking arc magnet does not operate to approach the carbons by reason of lost motion of the nut of the screw-bar in its guide.

From the winding of the striking arc magnet *m* the current leads direct to the frame of the lamp, the whole lamp being insulated from the drum. From the frame the positive carbon (the larger in the figure) receives current directly through the carbon-holder; thence the current crosses the arc to the negative carbon, and by its holder and a flexible connection to the negative lamp contact spring; thence to the drum sliding contact, wire connection, contact ring in turntable, a plunger, and flexible lead to the negative terminal of the switch *S* (Fig. 13). As the carbons (principally the positive) burn away the arc becomes attenuated, diminishing the luminosity of the crater, or the arc might break; to obviate this and trim the arc to proper length the automatic shunt feed is introduced consisting of the clutch magnet *K* and its operating parts.

The path of the shunt current is from the base of the lamp, through the contact of the circuit breaker *O*, through the clutch magnet *K* and switch *h* to the negative lamp contact spring. After starting, the carbons being apart, the current flows only through the clutch magnet *K* and attracts the armature *n*, but in doing so, the circuit is opened at the circuit breaker and the armature returns to its original position, being pulled back by the regulating spring *r*, reclosing the circuit; the armature is again attracted and this movement will take place as long as the carbons are too far apart. It results from the fact that the efficient arc is maintained at from 47 to 50 volts; as long as the voltage, due to increased length of arc, does not attain a value of greater than 50 to 51 volts the armature of the clutch magnet will not be attracted and the feeding system remains inactive.

The movement of the armature turns the lamp feeding screws by means of the clutch *p*, to which it is connected, and at each stroke brings the points of the carbons nearer to one another; should the carbons come in contact, the main current passes

through them, and through the arc striking magnet *m*, attracting its armature, and again striking the arc—this is, however, rare.

This armature *s* is mounted on the upper feeding screw and carries it along in its movement until the carbons are sufficiently separated to start the arc. After the arc is started, the clutch magnet *k* being in multiple with it, will be traversed by a current proportional to the drop of potential across the arc. As the carbons burn away this drop increases gradually and the current through the clutch magnet *k* finally becomes strong enough to overcome the tension of the spring *r* and attract the armature *n* bringing the carbons nearer together. The regulation of the lamp is therefore adjusted by the tension of the spring *r*. If by accident or careless handling of the lamp the adjustment should be disarranged, the lamp would not burn at the right voltage at the arc; a voltmeter should be connected across the terminals of the lamp, and if the voltage is below the normal, tighten the spring *r* until the adjustment is right; tightening the spring increases the length of the arc and consequently the voltage; loosening the spring shortens the arc and decreases the voltage.

This adjustment should not be disturbed unless in case of actual necessity.

Operation by Hand Feed.—First see that the automatic switch *h* (Fig. 15) is open and the carbons apart before closing the switch *S* (Fig. 13) on the projector base.

To start the lamp, bring the carbons together and immediately separate them to about ⅛-inch. The carbons should be fed every half minute by means of the crank-handled socket wrench on the post (or through the tube *L*, Fig. 13) at the back of the projector. Start feeding when the length of the arc is approximately about ¼-inch.

To Place the Lamp in the Drum.—Firmly clamp the wheel *B* (Fig. 13); if the front door is in place remove and place it in box. If the lamp is carboned, remove the carbons. Open the obturator shutters and turn the magnet piece until the opening points downward. Take hold of the lamp by the handle *a* (Fig. 15) and casting *b* (never by the carbon carriers) and let the back end of the lamp rest on the drum slides, still holding the front end up, push until the lamp falls into the two slots in the slides, then lower the front end into place. Press the lamp against the focussing screw and turn the wheel until the lamp

is caught and brought nearly in focus, *i. e.*, when the front end of the lamp is level with the white line marked on the drum. The sliding door can be opened to facilitate the operation. The magnet piece is to be turned down before placing the carbons.

To Focus the Lamp Whilst Burning.—It is not necessary to elevate or depress the beam for this purpose, though some operators regard it as more convenient; the vertical motion in this case should be elevation, and never more than 40 degrees; 25 degrees is a good and sufficient angle.

Move the lamp horizontally by means of the focussing screw *K* (Fig. 13), nearer to or away from the mirror until the beam of light has its *minimum divergence,* which for the parabolic mirror is about 3 degrees; if the beam diverges move the lamp from the mirror, if it converges move the lamp towards the mirror.

To Place the Carbons.—Separate the carbon carriers *v* (Fig. 15) as far as possible by means of the brass crank-handled socket wrench, which is kept in the tool box; insert the wrench in the tube at the back of the drum and push it in until it fits on the square head of the lamp feeding screw *c,* then turn it in the proper direction for separating the carbon carriers.

Place the negative carbon in position with the end even with the carbon clamp and tighten the screw *d* sufficiently to insure good contact; then place the positive carbon with its point ¼ inch away from the negative carbon, and with the end projecting through the clamp, then tighten the screw sufficiently for good contact. Bring the points of the carbons opposite each other by means of the vertical adjusting eccentric *f* and the horizontal adjusting screw *g* and close the obturator shutters.

Each carbon must burn evenly to otain the best results, the negative burning to a point, the positive forming a crater in the center; if they do not they must be adjusted by the adjusting eccentric.

The Search-Light Rheostat.

The single type is shown in Fig. 16. The type is not now used for other than 13-inch and 18-inch projectors, as rheostats for the larger sizes become large and have a dimension from front to back which renders them difficult to install in the locations required for convenient operation; in present practice the

major part of the resistance is installed in one box and without regulating lever—this permits installation at any convenient place along the search-light wiring line—the remaining resistance is enclosed in a small convenient box, having adjusting facilities, at the location of operation (usually near the switchboard).

The rheostat (or rheostats) are installed in series with the line and their office is to cut down the voltage, "have a drop," equal to the difference between the voltage at the switchboard and the operating voltage of the arc; this drop is equal to the resistance of the rheostat multiplied by the passing current. The energy is dissipated in heat and amounts, for a 30-inch search-light, to 5.7 kilowatts for each search-light, or for four, nearly 23 kilowatts, which approximates the total output of a 24 k. w. generator. The loss is severe and has occasioned the consideration of the introduction of a motor-generator for economy; but the intermittent and but occasional use of search-lights hardly warrants the extra device. The rheostats are classed by resistance, current capacity, voltage of the lamp, and line voltage respectively, as in the following example of a 24-inch projector; .62 (ohms), 50 (amperes), 50 (volts, lamp), 80 (volts, line).

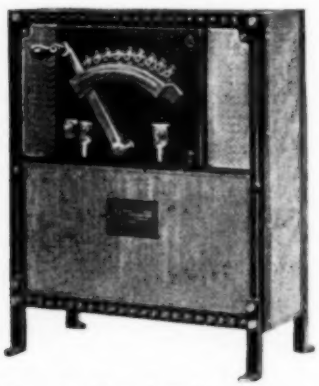

FIG. 16.—Search-light rheostat.

The rheostat consists of a dead resistance and an adjustable resistance made up of German silver ribbon, the whole enclosed in a non-combustible frame. The value of the total resistance (hot) allows about four volts below to six volts above the best working voltage of the lamp, the exact voltage required can then be obtained by manipulating the rheostat handle (which controls the adjustable resistance) until a point is reached at which the lamp will work best; as long as the lamp works satisfactorily at this point, the rheostat handle should not be tampered with. The words "*high*" and "*low*" are marked on the rheostat face to indicate in which direction the handle is to be moved to obtain an increase or decrease in the voltage respectively.

The rheostat should be connected in the positive side of the circuit.

Schuckert Company's Projector.—The projector, Fig. 17, in its standard form consists of the following main parts:

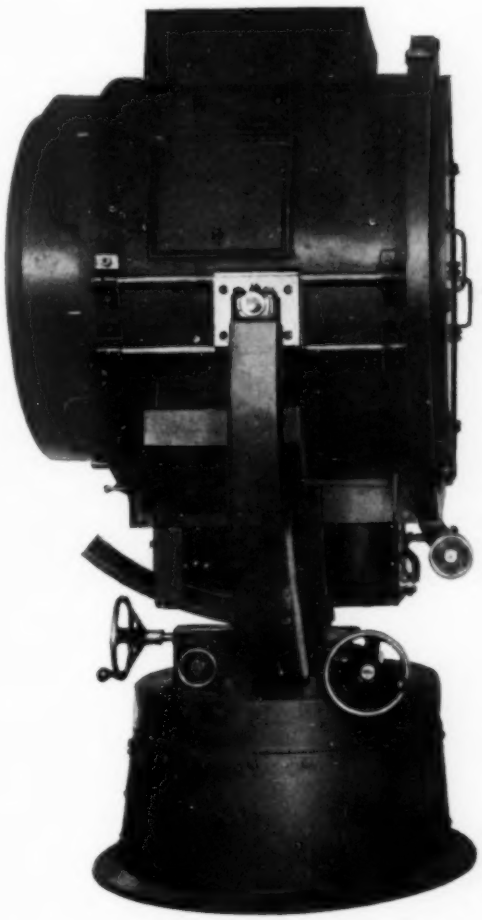

FIG. 17.—30-inch projector, Schuckert Company.

1. The foundation, or stand, with the ball-bearings for the turning-tables, the traverse for taking up the sliding rings and the electro-motors with the worm wheel axles.

2. The turning-table with the supports for the pivots of the

drum, the gearings for the vertical and horizontal movement of the drum by hand, and the electro-motors (when electrical control is used), the sliding brushes, chain spanners and the clutches.

3. The drum, containing glass parabolic mirror, lamp with device for moving the lamp, segment for centering the arc of light, "Iris Blind" (darkening apparatus), signalling apparatus, devices for observation and ventilation purposes, and further the necessary parts for the vertical movement of the drum, viz., the pivot, the pivot bearing and the toothed segment.

The stand consists of an upper part, the sheet-iron cone and the foot ring. These three parts surround the traverse which serves to take up the sliding rings and the electro-motors with their gearings. The upper part has a wedge-shaped groove, for taking up the steel ball rim, which serves as a bearer of the turning-table. The surface of the turning-table is level; a little further down, on the outside, is a grooved bracket on which the ball rim lies, and which centers the turning-table. At the inner side of the two ball rims an inner toothing is fixed into which work the raw-hide strips, which rotate the turning-table horizontally. The sheet-iron cone is coupled with the upper part; and the foot ring, and has two large openings for taking out the motors and two small openings for inner inspection. On the foot ring are four eyes with holes for screwing the projector on the stand.

In the center of the traverse a bronze bearing is inserted into which a hollow shaft bears and into the latter a full shaft. Both shafts carry chain wheels on their upper ends, chain and worm wheels on their lower ends; the motor axles work into the latter and are provided with worms. The motors are completely enclosed and have ball bearings which rarely need oiling. They also have ears on both sides and are screwed on bolts which are fastened on the traverse.

The Turning Table.—The cast iron, cap-shaped, turning-table bears the projector drum which is carried on two bronzed arms with cap bearings; the table rotates the drum about a vertical axis. The table rests with its inner side on a steel ball rim which lies in a groove of the stand and is centered towards the latter by a second ball rim placed between the wall of the turning-table and the stand; a center pivot is not necessary. On the turning-table are the enclosed gearings and coupling arrangements

for the horizontal and vertical movement of the drum.. Both gears are so constructed that, by using a coupling nut for each, they permit free movement by hand and hand wheel; this is effected by the following arrangement. The vertical worm shaft works into a loose worm wheel, which is fixed on a hollow shaft, and on which the spur wheel, outside the drum, is keyed to cause the driving of the drum case by a toothed segment. On the hollow shaft is also placed a coupling disc which can be coupled with the worm wheel by turning the coupling nut as far to the left as possible.. On the other side of the coupling disc is a second loose worm wheel, into which the horizontal shaft with hand wheel works; this effects movement by the hand wheel. By turning the coupling nut as far to the right as possible, the disc is coupled with this worm wheel and regulation by the hand wheel can be effected; for the intermediate positions of the coupling nut, none of the worm wheels are coupled, hence a free movement of the drum can be effected by hand.

For turning the projector horizontally within the ball bearings, the stand is provided with an inner toothed device, into which gears a cog wheel which is placed on a vertical shaft, the latter bearing in the turning-table. Above the shaft bearing in the turning-table, a worm wheel is placed on the hollow shaft which can be coupled with the coupling plate on the hollow shaft by screwing down the coupling nut. By turning the worm wheel regulation by the hand wheel in a horizontal direction can be effected. In the intermediate positions of the nut, neither the chain nor the worm wheel is coupled, thus enabling the turning table to be moved by hand.

On the turning-table are sliding brushes which conduct the current for the lamp from the sliding rings which are fixed on the traverse of the stand; movable rollers are also placed on the table which are embedded in movable forks, these are for the chains of the electro-motive impetus.

Strong clutches are screwed on the turning-table, at angles of 120 degrees, which work underneath the toothed rim of the stand and thus prevent the table from tipping over when lifting the projector.

The drum consits of a sheet-iron case with a horizontal trunnion, stiffened at both ends by rings, on which on the one end

the glass parabolic mirror with cast-iron frame is placed, and on the other the " Iris Blend " and the front door. The trunnions of the drum and the optical center of the mirror fall together. On the bottom part of the drum is a guide on which the horizontal lamp (hanging on rail brackets) is fixed and through which the detachable carbon holders pass into the axis of the drum. This guide is uncovered by two flaps, leaving a small slot which allows the arms of the carbon holders to pass through and move easily. The lamp itself can be shifted with the carbon holders in the direction of the mirror axis, enabling the placing of the crater of the positive carbons in the focus of the mirror to obtain a concentration of the beam of light.

For the displacement of the lamp a screw spindle is fixed which leads to a worm wheel nut; this nut is turned through the worm by a hand wheel, effecting the movement of the lamp. In order to get at the inner apparatus of the drum and keep it in proper order, several doors are fixed on the drum which work into corresponding grooves of the drum and make a light-tight space.

To prevent the various parts of the drum, and especially the mirror, from getting unduly overheated, ventilation holes are placed on either side of the drum and a chimney on top. These parts are provided with a large number of cross blinds to prevent the escape of light and the penetration of rain and wind.

To suspend the drum, with the pivots in the bearings of the turning-table arms, the two drum rings on either side are connected with two steel rods, on which the pivot bearer is fixed in a movable way, thus facilitating the insertion of the pivots in the horizontal axis of equilibrium of the drum.

On the right-hand side, at the bottom of the drum, is the toothed segment which is used for vertical movement and for which purpose it gears with the corresponding flange rail of the turning-table through a toothed wheel.

The glass mirror, equally thick all over, is cut parabolically on both sides and has an inside diameter of 750 mm. and a focal distance of 310 mm. The mirror is silvered on the back (convex side) and then varnished; the edge of the mirror is embedded with asbestos paper in a cast-iron frame and held in position by a large number of elastic sheet-brass angles. The mirror frame

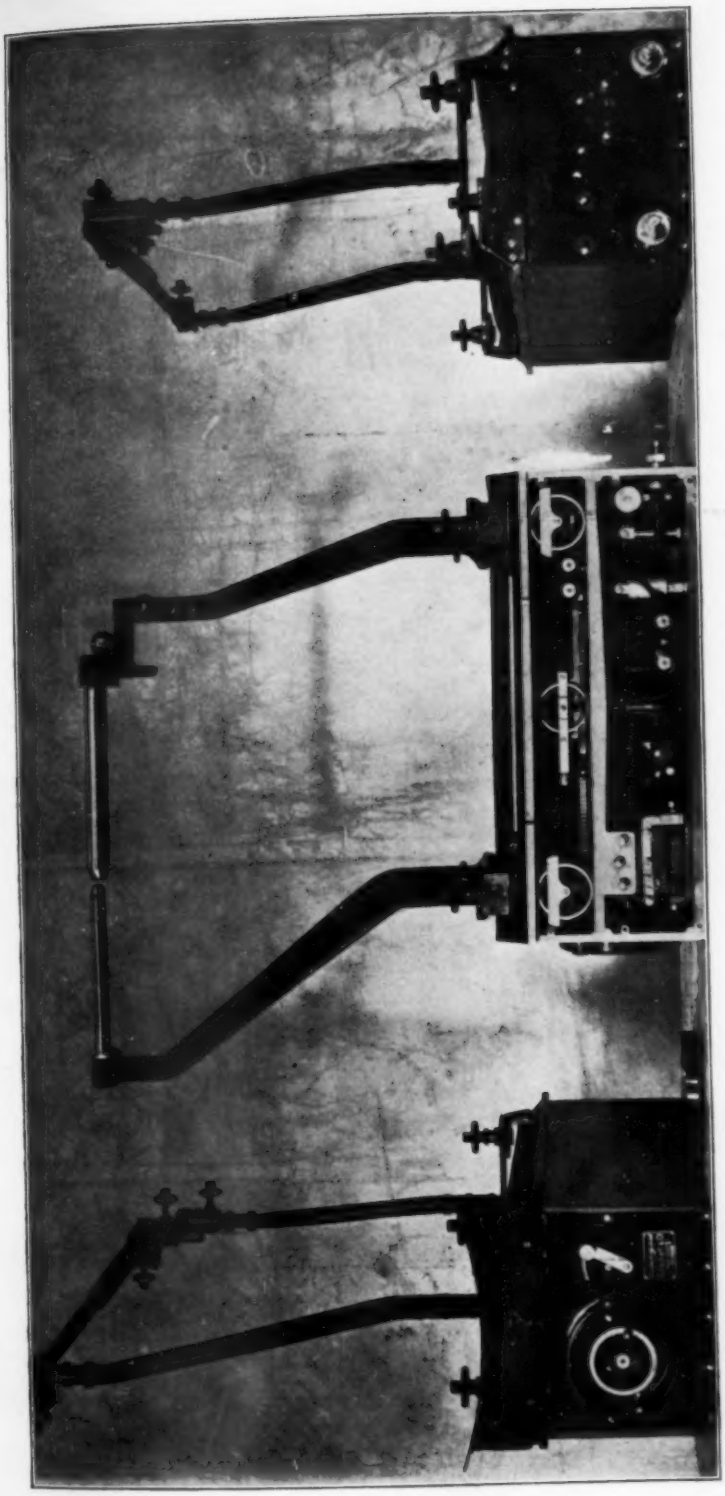

FIG. 18.—Lamp for 30-inch projector, Schuckert Company.

is fastened on by screws and nuts, the former being screwed in the drum ring at the back.

To protect the surface of the mirror at the back, a sheet-iron cover with ventilation holes is fixed on the frame.

Darkening Device.—The "Iris Blind" serves as an effective screen or shutter for the search-light ray. The apparatus consists generally of two concentric rings moving towards each other, one of which is usually tightly fixed on the front edge of the search-light, whilst the other ring can be twisted against the former. To enable an easy rotation of this large ring, it is provided with a groove on its circumference and embedded in a corresponding groove of the solid ring by a steel ball rim. Both rings are connected with one another by thin, sickle-shaped, brass plates, in such a way that the latter are fastened with the pivots on the movable ring whilst the other ends are connected with the fixed ring in the pivots by a short rod. By turning the ring the various sheets are pushed fan-like over one another and thus close the aperture of the projector from the edge towards the center, always leaving an opening of circular shape, which is gradually diminishing; this process much resembles the action of the iris of the eye. A total closing of the center cannot be effected by the sickle-shaped darkening plates themselves unless made extremely sharp; two plate-shaped discs, or blind plates, are therefore fixed in the center in such a way that they form a pulley (with the bottom parts screwed together), with edge-shaped groove, in which the sheets are pressed when closed, thus effecting a light-tight space. These blind plates do not absorb light even if the blind is open, as the center part of the mirror does not send out any useful light on account of the shadow of the negative carbon.

The "Iris Blind" is set in motion by a handle near the edge of the opening of the drum; a slit limits the distance the handle can travel.

Apparatus for Centering the Arc of Light.—To prevent a slant crater a segment of soft iron of about 240 degrees, concentric to the positive carbon, is fixed as near to the light arc as possible; the ends of the segment become magnetic poles to the current passing the carbons, thus creating magnetic lines of force. The latter diffract the arc until the crater is vertical to the axis of the carbon. The segment is supported by two sheet-iron

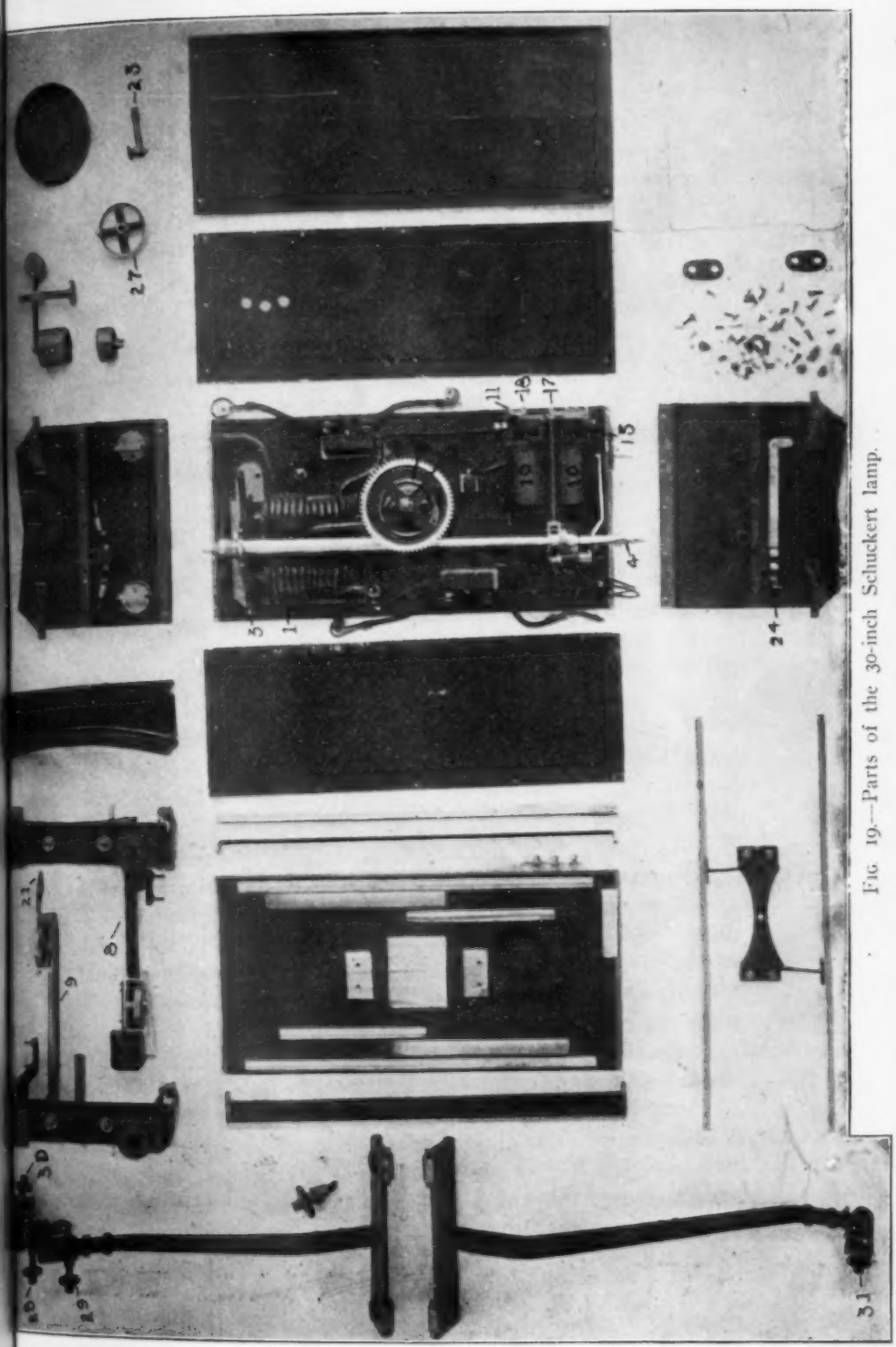

FIG 19.—Parts of the 30-inch Schuckert lamp.

bearers; it must be removed if the lamp is to be taken out, for which purpose the screw of the horizontal bearer is loosened and the whole put sideways round the lower jointed end of the other bearer.

Horizontal Shunt Lamp.—The lamp, Figs. 18 and 19, is automatic, but can also be regulated by hand, and in both cases be stopped before ignition; on the other hand it can be regulated either way while burning.

The automatic regulation chiefly consists of two magnet systems, one of which produces ("strikes") the arc when switched in, being called the striking arc magnet, whilst the other effects the pushing ("feeding") of the carbons when burning and is called the feed magnet. The arc former consists of a horseshoe-shaped magnet, the arms of which lie in the chief current of the carbons. In front of the pole tips of this electro-magnet, an iron armature 3, Fig. 19, swings on two movable spiral springs which are fastened on the lamp wall. The worm shaft is brought in contact with the iron armature in such a manner that it is forced to travel the same way as the armature.

On the vertical axis 5, is a worm wheel 6, and a toothed wheel 7; the latter gears with the two toothed rods 8 and 9, which are fixed on small movable cars (Fig. 18); the carbon holder arms, jutting on the axis of the mirror, are insulated and placed in sockets of the small cars; the current is led direct to these arms by flexible cables and then to the carbons.

On the lower lamp plate is further placed the feed magnet 10, a horseshoe-shaped electro-magnet. The angle on which the armature bears has on one side an insulated contact screw 11, on the other side the armature 13, with a contact spring; the armature is drawn towards the screw 17 by two screws and movable springs, thus causing the contact spring to come alongside the contact pin 18; the contact spring and pin lie, together with the magnet winding, in the shunt to the carbons. This shunt is interrupted to a certain degree as soon as the armature 13 is attracted by the magnet 10; the shunt is restored as soon as the armature is drawn off by the worm spring. On the armature is a trigger pin 19 which, when attracted, glides over the rack wheel 20 (the latter being fixed on the worm shaft 4), but, when going backwards, it drags the rack wheel along and

thus causes a rotation of the worm shaft 4. This rotation is transferred to the toothed wheel 7 by the worm wheel 6 and thus causes the carbons to approach.

If the carbons do not come in contact with each other when the current is closed the feed magnet begins to act; the automatic opening and closing of the circuit causes the armature to swing rapidly, thus turning the back wheel 20, worm shaft 4, and toothed wheel 7, bringing the carbons together. As soon as the carbons touch each other, the current in the feed magnet 10 is no longer interrupted, the striking arc magnet 1 and 2, however, is strongly excited; consequently its armature is attracted and pushes the worm shaft, with worm wheel and toothed wheel, forward, the carbons are separated from each other, and form the arc of light.

As the burning of the carbons continues, the feed magnet becomes so powerful, owing to the increasing voltage, that it attracts its armature and overpowers the worm springs, until the automatic breaker interrupts the circuit, the armature drops back, sets the rack wheel 20, and also the worm and toothed wheel in motion by the trigger pin 19, and the carbons approach each other. The approaching movement is very small in consequence of the worm transmission and takes place at small intervals, occasioning steady feeding. If the carbons have burned to a certain length, that is, if the toothed rods have arrived at their end position, the current of the feed magnet 10 is interrupted by lifting the spring 22 by a pin 21 on the positive toothed rod 9; the magnet 10 then ceases to work and the arc of light extinguishes slowly.

Hand Feed.—The automatic regulation of the lamp can be switched off and the feeding of the carbons be effected by hand; for this purpose the lever 23 on the rear of the lamp is set from *A* (automatic) to *H* (hand) thus interrupting the circuit of the feed magnet; the contact block 24 which forms the connection, is drawn away from the two springs. The pin 19 is then taken off by the ratched wheel 20, as the pin would hinder the free backward movement of the wheel 20. To bring the carbons nearer the focus, the small wheel 27 must occasionally be turned in the opposite direction to the hand of a watch. If the hand regulation is to be employed from the start, the carbons must first be made to touch each other by turning the small hand

wheeel 27, the carbons must then be quickly separated so that the arc light can attain its proper length.

A rheostat is supplied with the Schuckert projector, which is essentially the same as that used with the General Electric Company's projector.

Focussing.—On both sides of the drum are inserted round, dark, framed glasses which permit observation of the arc of light from the side. In order to control the position of the carbons from above, a little apparatus is fixed in the case, consisting of a mirror and a lens, which reflects an image of the arc of light upon a frosted glass inserted on the top of the case. The larger search-light projectors are also provided with a similar projection apparatus for the observation of the arc of light from the side, reflecting an image on the same frosted glass so that the images are placed underneath each other and by this means the proper insertion of the carbons is effected, as the axes fall together. In the center of the frosted glass is a vertical mark by which the positive carbon can be set in the focus of the mirror in the following way. The ray of the search-light is directed towards the sky at an angle of 20 to 30 degrees and the focus changed by shifting the lamp until the observer, who stands near the search-light projector, finds the beam sufficiently conically pointed (this is caused by the perspective, as the ray is slightly conically extended and drawing to a point should be continued until the ray appears to be shut in behind the point); the beam will then be that for the most favorable position of the crater towards the mirror and it is only necessary to bring the image to the mark of the frosted glass in such a manner that the crater edge and mark are in coincidence to obtain and retrace the right position of the crater by the mark.

Remarks on Care and Cleaning.—The lateral sheet-iron plate of the lamp case can be taken off, permitting access to the interior and an inspection of the gearing, flange rails, pulleys and toothed rods, also for a thorough cleaning with brush and rag.

For lubricating purposes, only the finest watch oil should be used and care must be taken, that it is entirely free from dust.

In handling the inner mechanism, the movable cables must not be damaged or displaced; the edged nuts of the cables must be well screwed on, but the ears on which the cables are suspended should permit of easy movement. Contact and worm

springs on the armatures must not be bent. All contact parts must be kept metallically clean, and care must be taken that the nuts and screws are well screwed on.

If the apparatus is in constant use, it must be cleaned at least once a week. Ashes and particles of carbons which collect on the surface of the lamp, *are not to be blown off*, but are to be carefully brushed off towards the front or back.

Should the feed magnet already operate at a lower voltage than 51.5 volts, the springs have become too weak; this can be remedied by extending the screws until a voltage of 51.5 volts effects the regulation.

Before the lamp is set to work, care must be taken that the carbons are of sufficient length; if new carbons are to be inserted, the carbon holders are extended to their fullest length by the small hand wheel 27; the screws 30 and 31 are raised, the carbons inserted and the screws slightly tightened up again. The positive carbon is then adjusted by the two discs 28 and 29, the former of which serves for the horizontal, the latter for the vertical movements; the position of the carbons is correct when their axes are in the same line. The screws 30 and 31 on the carbon holders should be oiled from time to time. If old carbons are used, it will be advisable to file the two carbon ends into the shape which they tend to assume through burning; the carbons must not touch each other before they are switched in and care must be taken that a good crater is formed from the start. Should the arc of light become one-sided, it can be remedied by so adjusting the positive carbon by the discs 28 and 29 that the less used part of the crater of the positive carbon approaches the point of the negative carbon. For automatic regulation, it should be noted that the stop lever at the back of the lamp is set at *A*. The voltage at which the regulation of the lamp is effected is 51.5 volts; immediately after the lamp is switched in, it works at a lower voltage; when the carbons and wire windings have attained a proper rise of temperature, the feeding will be effected at the normal voltage of 51.5 volts.

General Notes on Projectors.—Dispersing, or diverging, lenses are no longer used.

The principle of operation of the search-light is as follows: With a current of sufficient strength passing through the lamp carbon electrodes, which are first placed in contact and then

separated to about ⅛ inch, a brilliant arc is formed which consists mainly of volatilized carbon particles. The electrodes are consumed, first, by actual combination with the oxygen of the air; and second, by volatilization under the combined influence of the electric current and the intense heat. As a result of the formation of the arc, a crater is formed at the end of the positive carbon. The crater is due to the greater volatilization of the electrode at this point than elsewhere. It is the seat of highest temperature of the arc and is the main source of the light afforded. The major portion of the brilliant light emitted by the carbons is reflected by the mirror and passes out through the plain glass door (in the front of the projector) in a parallel beam.

The beam can be thrown horizontally in any direction, and vertically at any angle (within certain limits) by manipulating the hand control. Regarding the vertical movement of the projector: it is dangerous to keep the beam of light higher than 40 degrees above the horizontal for any length of time, as pieces of incandescent or hot carbon may fall on the mirror and cause it to break. It is only in case of absolute necessity that this limit should be reached or exceeded.

The clutch *p* (Fig. 15) of the General Electric lamp, being the only delicate part of the lamp, has been so located as to be easily removed and inspected.

It can happen that the clutch magnet will keep on working and yet not feed the carbons, due to the following causes:

1. *The Feeding Screw Working Too Freely.*—In this case the whole clutch would move backward and forward at each stroke instead of moving one way only. To remedy this tighten slightly the brake *w* at the back of the lamp.

2. *The Stopping of the Clutch.*—In this case the clutch box would remain stationary and the lever work up and down without turning it; this would be due to oil or water inside the clutch. To remedy this the clutch must be opened and cleaned.

In either of the above cases the lamp could be controlled by hand and would appear to be in working order.

3. *The Sticking of the Clutch.*—This is due to dirt inside, in which case the lamp could not be controlled by hand. To remedy this the clutch must be taken off, opened and cleaned. To remove the clutch, unscrew the nut fixing it to the feeding screw and take out the small pin on the end of the connecting

rod; the clutch can then be pulled out. Open the cover by loosening its two screws, wipe all parts with a clean dry rag and put them back in place.

The two adjusting screws in which the clutch lever rests when in place, *must not be moved.*

4. If the carbons are left burning too near each other a mushroom will form at the end of the negative carbon and which will cut out a great deal of light. The mushroom must be broken as soon as it gets small enough at the neck to permit. To break it, move the positive carbon up and down quickly by means of the adjusting eccentric; bring the carbons to the center as soon as it is broken.

The mirror in the projector gets very hot, consequently great care should be taken not to let any cold air inside the projector drum after putting out the lamp, or while the lamp is in operation, as it might cause the breaking of the mirror. Before turning off the switch on the base of the projector, see that all doors are closed.

If the lamp is put out only to change carbons, the change must be made through the side doors, turning the projector so as to have the opening to leeward; the same course must be followed if for any cause the front door is to be removed.

To prevent damage to the obturator, the carbons must be removed from the lamp when placing it in or taking it out of the drum.

Use the wooden-handled socket wrench to tighten the carbon clamps and also to work the carbon adjusting screws, should it become necessary while the lamp is burning.

The person in charge of the projector must never leave it while in operation, he must constantly watch the burning of the carbons and the focussing of the lamp.

The lamp must be kept clean and free from carbon dust, using the dusting brushes provided for that purpose. Do not blow the dust off. Take care no carbon dust gets into the lamp mechanism or clutch, also keep the drum contact slides and contact guides free from dirt and carbon dust.

Clean off the mirror and front door with a dry rag and polish with chamois skin.

The only parts of the lamp mechanism of the General Electric lamp to be oiled are the four bearings of feeding screws and

the pivot of the armature of the clutch magnet. Clock oil is to be used; be careful to wipe off all the surplus oil. Do not oil carrier slides or clutch. Oil the trunnions and the working parts of the base. Do not oil whilst operating.

After every run, the projector should be put in condition for the next run.

If the projector is not to be used again for some time, the canvas cover should be put over it.

Facing the switch on the projector base, the positive pole is to the left and the negative to the right.

There is often some little flaming of the carbons which cannot be controlled by the rheostat; it is unimportant except from the fact that it decreases the intensity of the light; it will usually disappear of itself. It occurs more frequently when the crater is not central in the positive carbon or when the carbons are not in exact line.

Some hissing will occur when starting up, especially with new carbons, and the lamp will not quiet down until a good crater has been formed in the positive carbon. This can be obviated by reaming out the crater in the positive carbon with a penknife before putting it in the clamp.

Flaming and hissing are promoted by inferior carbons and are much increased if the carbons have absorbed oil. Those now provided are of the Schmelzer or Electra manufacture and are very homogeneous; the positive carbon is bored axially and cored with a soft carbon, which materially assists in maintaining a good crater. Negative carbons have been sometimes cored, but this expedient is quite apt to conduce to the formation of mushrooms. In order to obtain the best results the carbons must be hard, homogeneous and of the best quality. Soft carbons fuse and cause mushrooms on the negative carbon which cut out a large portion of the light and prevent the arc from burning steadily.

The momentary current at starting, especially of short circuit if the carbons touch, is ordinarily heavy and quite sufficient to throw the pointer of the ammeter clear across the scale and against the stops; it need occasion no apprehension if it does not continue; if it does, the switch at the switchboard should be quickly opened. This starting current may be as much as 50 per cent above the working current.

Abnormal current shown by the search-light ammeter is often traceable to either a mushroom on the negative carbon or careless handling of the crank wrench. In most cases of fusing of the contact plungers in the pedestal there has been direct evidence of an attempt to regulate the feed by hand when the automatic gear was switched on. If the lamp does not feed it is for the reason that there has been a burn-out or difficulty in the automatic feed, or that the lamp itself is not clean, and in 90 per cent of the cases dirt is the cause; any attempt to remedy matters by use of a crank wrench, while the current is on, is quite sure to short-circuit the lamp and produce overload.

As a rule it is better to set the carbons before operation and permit no use of the wrench except in focussing. The automatic feed is a very desirable expedient and will give good report of itself if not impeded by an impatient use of the crank wrench. There is rarely any occasion for using the wrench on the screw bar after the lamp is in automatic operation.

The key to good search-light operation and management is thorough cleanliness in all the parts and frequent opportunity for practice by those who are not ordinarily called upon.

The mirrors will spot or frost in time; the action is much hastened on board ship by the practice of exposing them to the rays of the sun while drying out the barrel. There is nothing that will so quickly ruin the silvered surface of a mirror as the action of direct sunlight. Keeping the cover on the projector too much causes sweating, as in the familiar example of the case of guns; it has an important effect in loosening the silvering (frosting).

Inspection of Search-Lights.

Mechanical Construction.—The main points are:

The base is to contain the electrical connections and be so arranged that it can be bolted securely to the deck or platform.

The turntable to revolve freely in a horizontal plane and indefinitely in either direction, or be clamped rigid.

The drum to be trunnioned on two arms bolted to the turntable, giving free movement in the vertical plane; to be designed to be rotated on its trunnions by hand, or clamped rigidly. The vertical movement to cover an arc of 70 degrees above or 30 degrees below the horizontal.

The front of the drum to be provided with a glass door composed of strips of clear plate glass; the door to be readily removable.

The drum to be thoroughly ventilated and fitted with peep sights for observing the arc in two planes, and to have hand holes for access to the interior.

All projectors to be finished in dead black, excepting working parts, which are to be bright.

The Lamp.—*Operation.* The lamp is removed from the drum, and connected up with an electrical source of the same potential as that of the vessel in which the projector is to be used; usually 125 volts is the standard of test.

The rheostat, and an ammeter are connected in the positive leg (unless a shunted ammeter is to be used); a voltmeter is connected across the supply line, and across the carbons at the clamps of the holders.

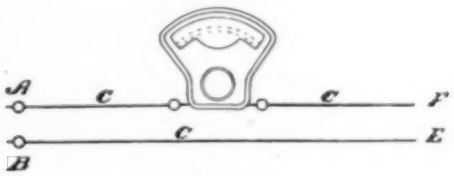

FIG. 20.

The cold resistance of the magnet windings is then taken for calculation of heat rise.

New carbons are put in and the lamp is started in the usual way.

The voltage across the arc just before and just after starting should be noted.

The lamp is then burned for six hours or until the carbons are exhausted.

Note that the arc is well centered and that the motion is steady and even.

Note the voltage and time whenever the feed begins to operate, and voltage when it stops.

Flaming should be slight; note its color.

Note any hissing or sputtering; the best condition is none of either; any sulphurous smell; there should be none; any chipping off of small pieces of carbon; there should be none.

The color of the carbon ash should be grey, not red; the amount of ash should be small.

Note formation of mushrooms on the negative carbon; good negatives should not occasion it; the time of burning out of the carbons, if less than six hours.

At the end of the run the drops on the magnet windings are taken whilst hot, from which the heat rise is calculated.

Insulation Resistance.—The insulation resistances of the lamp are commonly taken when at this stage as being more convenient than when run in the projector.

[NOTE 5.—The method of measuring insulation resistance which is always pursued is by the voltmeter method, which is quite sufficient for any laboratory or ship test.

Referring to Fig. 20, *A* and *B* are the positive and negative terminals of any supply line from the switchboard, and *C*, *C*, *C* are leading wires.

First: If the ends of the leading wires, *E* and *F*, are touched together, there will be a deflection in the voltmeter, which is the voltage of the supply line (neglecting resistance of leads).

Second: If *E* (or *F*) is touched to the conductor and *F* (or *E*) is connected to ground or to the adjacent metal from which the conductor should be insulated, there will be a smaller deflection by reason of the extra resistance of insulation between the conductor and the ground or the adjacent metal.

Neglecting minor resistances, the current passing in *first* above would be:

$$C = \frac{V}{R} \tag{1}$$

in which V is the voltage of the supply line and R is the resistance of the voltmeter.

In *second* the current would be

$$C_1 = \frac{V}{R + R_1} \tag{2}$$

in which C_1 is the current due to V and $R + R_1$; R_1 being the resistance of the insulation.

Since the deflections for the small arc of the voltmeter may be considered as proportional to the currents, we may substitute D and *d* for C and C_1.

Substituting, dividing, and clearing for R_1:

$$R_1 = \left(\frac{D - d}{d}\right) \tag{3}$$

The insulation resistance (hot) which is usually expected is one megohm.

While voltages on board ship are those commonly used for ships' tests, inspection voltages should be 500 volts, as it has been determined by experiment that the resulting insulation resistances increase rapidly as the

voltage falls below 500 volts, and are unduly high at low voltages, while for 500 volts and above the results are fairly constant.

The resistances of voltmeters are always marked on the instrument or on the case.

Often, as in testing, it is only desirable to know that the insulation re-

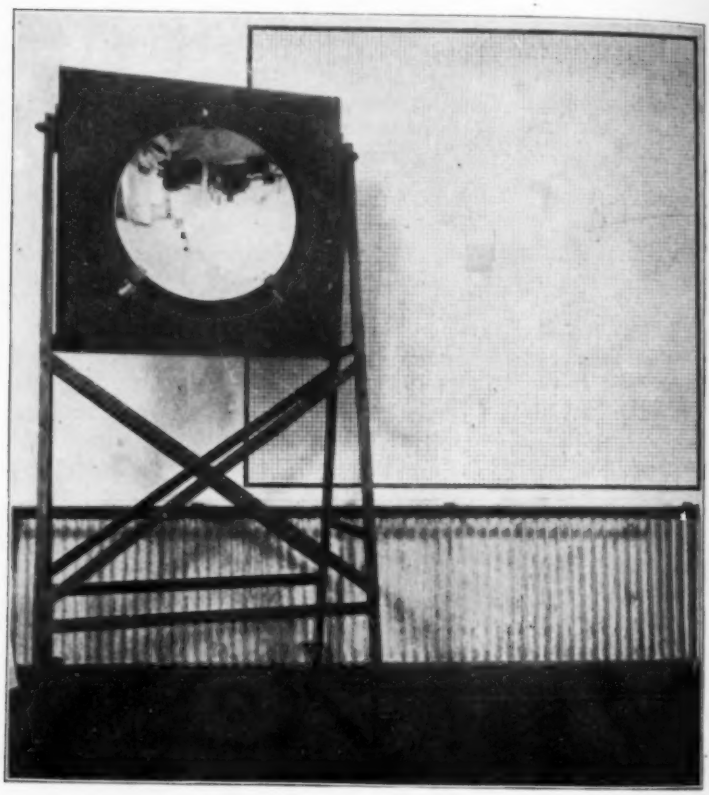

FIG. 21.—Grating test for mirrors.

sistance is at least one megohm; formula three above is then used in the more convenient form

$$R_1 = R\left(\frac{D}{d} - 1\right)$$

from which, knowing R_1 and D approximately, can be calculated the value of d for $R_1 = 1{,}000{,}000$ ohms: evidently this will be the highest value which d can have, and hence if the voltmeter under *second* above shows a deflection greater than this value of d, R_1 will be less than one megohm: that is, the insulation resistance is not satisfactory.]

The measurements of insulation resistance to be taken for the lamp are: each magnet winding to lamp frame; positive contact spring to lamp frame; negative contact spring to lamp frame; lamp frame to ground (in the projector).

Carbons.—The test of the lamp covers most points in testing the characteristics of the carbons.

They should be hard and homogeneous; without cracks; be round; be straight within 1/16 inch for the entire length; and give a clear, metallic sound when struck.

It is usual to determine the hissing curve, for a particular type of delivery, as proposed by Ayrton; the curves afford a ready graphic means of comparing carbons of different lots or makes.

Mirror.—*Cover and Frame.*—The mirror cover on the drum should be lined with asbestos to protect the operator from the heat; and, while being readily removable, should be capable of firm and secure assembly.

The mirror frame should have a large number of springs which will hold the mirror securely and centrally in place and afford good cushioning, against concussion and shock.

Glass, Silvering, and Backing.—The glass should be clear and free from blow holes and "stars."

The silvering should be even, smooth and free from blotches or frosting; these latter are readily detected by slanting the mirror in different positions.

The backing should be a hard, durable paint, unaffected by heat. It should assure perfect opacity when looking through; this is tested by holding the mirror against the rays of a strong light, an arc light is customarily used.

Curvature.—In this test the focal length is first measured. The mirror is exposed in a frame to the direct rays of the sun when the point of convergence will be immediately recognized and the distance to the mirror can be measured; if there is doubt, the point of convergence can be searched by a piece of paper, which will take fire at the focus.

The mirror is mounted in a frame (Fig. 21), accurately plumbed and accurately centered in front of the square hole of a partition on which is painted a large square, ruled off into smaller squares of about two-inch sides. A camera is inserted in the square hole of the partition and the ruled square illuminated by an arc light.

Fig. 22 shows the photographed results for a rejected mirror in which the lines clearly show poor workmanship in grinding toward the outer edges; for a good mirror the lines are quite straight and equi-distant.

Intensity.—The projector is mounted on a platform and directed at a 10 by 20 foot white target placed 4000 yards for 18-inch mirrors, 5000 yards for 24-inch, and 6000 yards for 30-inch.

The very best conditions of a clear, dark night must be chosen

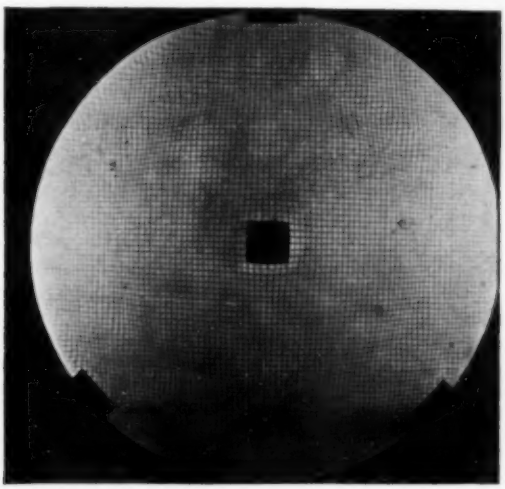

FIG. 22.—Inferior grinding shown by test.

for the test; mist and fog interfere importantly with the penetration of the beam; in the latter case—fog—the beam will not penetrate farther than one or two hundred yards.

Under best conditions the target should show clearly and distinctly.

A further test of carbons, and operation of the lamp when in the projector, is made, after which the following insulation resistances are taken: plungers of base to base; positive and negative leads to base; drum contact springs to drum.

CHAPTER III.

STANDARD WIRE.

Wire for naval use is divided into three general classes:

I. Lighting Wire.—The wire for circuits leading to connections or outlets for which the electrical potential generated by the dynamo is to be used for lighting, or for the operation of motors or other apparatus.

II. Bell Wire.—A type for interior communication circuits which are to be operated by the lower voltage of primary batteries or dynamotors.

III. Cable.—In which single insulated wires are jacketed together or bound together into a circular cross-section for convenience in handling and running; the type affords a reduced cross-section by the elimination of the braid on the separate wires, insures water-tightness particularly when many interior communication lines run through decks and bulkheads, and materially assists in localizing connections.

Construction of Wire.

The general features of the construction of standard wire are illustrated in Fig. 23 and consist of:

1. A *copper conductor, A,* to give the required carrying capacity for the current which is to flow through it.

The smallest cross-section which will contain a given area is the circular, and wires are as a rule made cylindrical. To obtain circularity of section and at the same time gain flexibility the copper conductor is made up of a number of evenly tinned, single wires of 98 per cent conductivity (compared with pure copper), stranded in the so-called "geometric series" consisting of 1, 7, 19, 37, 61, 91, or 127 [$1 + 6 \times 1 + 6 \times 2 + 6 \times 3 + 6 \times 4 + 6 \times 5 + 6 \times 6$, etc., having a summation, $S = 1 + 3n\ (n - 1)$] single wires in two, three, four, or more layers. The circular construction is farther assured by winding each layer in the opposite direction to that of the last.

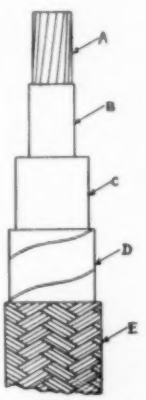

FIG. 23.—General idea of wire construction.

To insure maximum flexibility the pitch of the "standing" or "spiral" lay of all conductors so formed are not to exceed the following tabulated values:

Number of wires forming strand.	Length of pitch expressed in diameters of individual wires.
7	30
19	60
37	90
61	120
91	150
127	180

All single wires forming a strand are of the *diameters* standardized as the "Brown and Sharpe Gauge" as adopted by the American Institute of Electrical Engineers, October, 1893; they are *designated* by the cross-section in circular mils, a notation in which the circular mil is the area of a circle whose diameter is one-thousandth of an inch. The circular mil notation gives a much simpler means of calculation than that involved in the usual method for the area of a circle; in the strand the total number of circular mils is the number of circular mils of the unit, single wire, multiplied by the number of single wires used for that strand.

Due to the twist in stranding, a longer length of single wire being necessary to form the finished strand, the conductivity of a strand is required to be only 95 per cent of that of pure copper instead of the 98 per cent required in the unit wires. It is practicable to obtain unit copper wires of 99 per cent conductivity.

2. *Insulation of the copper conductor, B* and *C*, is to prevent electrical leakage to surrounding material, in other words a protection against grounds, leaks, and short-circuits.

[NOTE 6.—A ground is an undesired connection from an electric conductor or contact to adjacent metal, etc. Its resistance may vary between wide limits, being practically nothing when metallic contact occurs. Its general effect is uneconomical waste of energy.

A ground upon one side of a system only will not affect its operation; that is, if a negative (or positive) wire be connected to the metal, to earth, no leak will occur; no current will flow, provided the positive (or negative) wire of that circuit is properly insulated: but if this positive (or negative) wire be imperfectly insulated, "have a ground" also, leakage and consequent loss of energy will ensue. A partial ground on both sides produces a *leak*, and a dead ground on both sides, a *short-circuit*.]

The wire insulation consists of two elements:

The *first element, B,* is a layer of *pure Para* rubber, which is taped or rolled on to a thickness of about 1/64 inch and is adherent to the copper conductor; it is the ultimate reliance for insulation when its vulcanized-rubber covering, *C,* cracks or flakes, and it becomes mandatory that this layer be of the finest grade of Para rubber, a variety which is the best of the commercial classification. The layer must be 98 per cent pure Para rubber, concentric, of uniform thickness, elastic, tough, and free from flaws and holes.

The *second element, C,* consists of a layer of vulcanized-rubber composition; the compound consists of the best grade of fine unrecovered Para rubber, mixed with sulphur and dry inorganic mineral matter only and containing from 39 to 44 per cent, by weight of fine Para rubber, and not more than 3 per cent, by weight, of sulphur; not more than two-tenths of one per cent of free sulphur is permissible. The layer must be concentric, continuous, free from flaws and holes, and must have a smooth surface and a circular section.

All vulcanized rubber compositions tend to farther vulvanization at any temperature, more rapidly at higher temperatures, until a hard, brittle composition results, in which condition the layer is easily flaked off or cracked; this points out the necessity of allowing an excess in the carrying capacity of the conductor to prevent undue heating and to the avoidance of overload on the circuit wires by installing lights or apparatus whose amperage was not allowed for in the original wire size. The magnitude of the effect on the insulation can be exemplified by considering the fact that the heating effect is C^2R, and that, should the load be doubled, the heating effect would be four times as great; as the resistance would be greater due to heating, the insulation would be subjected to heating conditions over four times that for which it was calculated the completion of vulcanization would be materially hastened, and the undue heating would assist in producing cracking or breaking of the vulcanized rubber layer aside from mechanical injury in handling. There is another factor in the consideration which is that vulcanized products always contain an appreciable quantity of free sulphur; this free sulphur not only combines with the pure Para rubber layer, including it in the process of vulcanization, but it is also hygroscopic, intro-

ducing moisture into the interstices of cracked insulation to promote the occasion of grounds on the line, particularly when there is water in the molding or conduit. It is this injury to the pure Para layer which forms the basis of the restriction of free sulphur to two-tenths of one per cent; it occasions no especial difficulty to manufacturers.

3. *A cotton tape, D,* 1/32 inch in thickness, soaked with a rubber insulating compound; the tape is usually lapped one-half its width in laying on and is so worked as to insure a smooth surface and circular section of the rubber composition beneath, and must not adhere to the rubber. The especial office of this tape is to prevent any deformation of the smoothness of surface or circularity of section of the rubber composition, *C,* in order to secure a neat working fit in a standard rubber gasket, which is to closely fit on the layer, *C,* or over the outer braid and assure watertightness of the joint; measured dimensions "over vulcanized rubber" or "over tape" must come within 2½ per cent of tabulated values, the departure in no case to exceed 1/32 inch.

4. *A braid, E,* is principally to protect the construction beneath it from mechanical chafe and injury. Its size of thread and the number of threads (usually spoken of as "ends") are determined by the diameter to be covered. All braid must be clearly woven and, silk braid excepted, must be thoroughly saturated with a black, insulating waterproof compound, which compound will neither be injuriously affected nor have an injurious effect on the braid at a temperature of 95° C. (dry heat), or at any stage of the baking test, nor render the construction less flexible. Measurements "over braid" are required to come within 5 per cent of the tabulated values, the departure in no case to exceed 1/32 inch. There may be two exterior braids, but wherever a diameter "over outside braid" is tabulated or specified the outside surface must be sufficiently smooth to secure a neat working fit in a standard rubber gasket of that diameter (over outside braid) for the purpose of securing a watertight joint.

Lighting Wire.

Lighting wire is classed as: Single Conductor, Twin Conductor, and Double Conductor. When greater conducting area than that of 14 B. & S. G. is required, the conductor is stranded

in a series of 7, 19, 37, 61, 91, 127 wires, the strand consisting of one central wire, the remainder laid around it concentrically, each layer is twisted in the opposite direction from the preceding.

Single Conductor.

TABLE OF STANDARD DIMENSIONS.

Approximate C. M.	Actual C. M.	Number of wires in strand.	Size of B. & S. G.	Diameter, inches. Over copper.	Diameter, inches. Over Para rubber	Diameter in 32ds of an inch. Over vulcanized rubber.	Diameter in 32ds of an inch. Over tape.	Diameter in 32ds of an inch. Over braid.
4,000	4,107	1	14	.06408	.0953	7	9	11
9,000	9,016	7	19	.10767	.1389	10	12	14
11,000	11,368	7	18	.12090	.1522	10	12	14
15,000	14,336	7	17	.13578	.1670	10	12	14
18,000	18,081	7	16	.15225	.1837	11	13	15
20,000	22,799	7	15	.17121	.2025	12	14	16
30,000	30,856	19	18	.20150	.2328	12	14	16
40,000	38,912	19	17	.22630	.2576	13	15	17
50,000	49,077	19	16	.25410	.2854	14	16	18
60,000	60,088	37	18	.28210	.3134	15	17	19
75,000	75,776	37	17	.31682	.3481	16	18	20
100,000	99,064	61	18	.36270	.3940	18	20	22
125,000	124,928	61	17	.40734	.4386	19	21	23
150,000	157,563	61	16	.45738	.4885	20	22	24
200,000	198,677	61	15	.51363	.5449	22	24	26
250,000	250,527	61	14	.57672	.6080	24	26	28
300,000	296,387	91	15	.62777	.6590	26	28	30
375,000	373,737	91	14	.70488	.7361	29	31	33
400,000	413,639	127	15	.74191	.7732	30	32	34
500,000	521,589	127	14	.83304	.8643	34	36	38
650,000	657,606	127	13	.93548	.9667	38	40	42
800,000	829,310	127	12	1.05053	1.0818	42	44	46
1,000,000	1,045,718	127	11	1.17962	1.2109	46	48	50

WIRES USED IN STRANDS.

Actual C. M.	Size of wire B. & S. G.	Diameter, inches, over copper.
1,288	19	.03589
1,624	18	.04030
2,048	17	.04526
2,583	16	.05082
3,257	15	.05707
4,107	14	.06408
5,178	13	.07196
6,530	12	.08081
8,234	11	.09074

All single-lighting conductors are insulated as follows (Fig 24):

A layer of pure Para rubber, *B*, not less than 1/64 inch in thickness, rolled on. On the larger conductors this thickness must be increased, if necessary, to meet the requirements of the bending test.

A layer of vulcanized rubber, *C*.

A layer of cotton tape, *D*.

A close braid, *E*, to be made of No. 20 two-ply cotton thread, braided with three ends for all conductors under 60,000 circular mils, and of No. 16 three-ply cotton thread, braided with four ends, for all conductors of and above 60,000 circular mils.

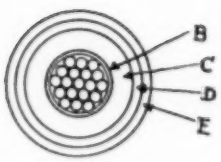

FIG. 24.

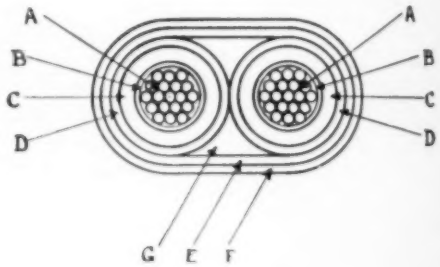

FIG. 25.

FIG. 24.—Cross-section of lighting conductor.

FIG. 25.—Cross-section of twin conductor.

Twin Conductor.

TABLE OF STANDARD DIMENSIONS.

Approximate C. m.	Actual C. M.	Number of wires in strand.	Size of wire B. & S. G.	Diameter, inches.		Diameter in 32ds of an inch.						
				Over Copper.	Over Para rubber	Over vulcanized rubber.	Over tape.		Over 1st braid.		Over 2d braid.	
							One conductor.	Two conductors.	One conductor.	Two conductors.	One conductor.	Two conductors.
4,000	4,107	1	14	.06408	.092	5	6	12	8	14	10	15
9,000	9,016	7	19	.10767	.139	7	9	18	11	20	13	21
11,000	11,368	7	18	.12090	.156	8	10	20	12	22	14	23
15,000	14,336	7	17	.13578	.172	8	10	20	12	22	14	23
18,000	18,081	7	16	.15225	.190	9	11	22	13	24	15	25
20,000	22,799	7	15	.17121	.209	10	12	24	14	26	16	27
30,000	30,856	19	18	.20150	.243	11	13	26	15	28	17	29
40,000	38,912	19	17	.22630	.268	12	14	28	16	30	18	31
50,000	49,077	19	16	.25410	.298	13	15	30	17	32	19	33
60,000	60,088	37	18	.28210	.327	14	16	32	18	34	20	35

All twin-lighting conductors consists of two conductors, each one of which is insulated as follows (Fig. 25):

A layer of pure Para rubber, *B*, not less than 1/64 inch in thickness, rolled on.

A layer of vulcanized rubber, *C*.

A layer of cotton tape, *D*.

Two such insulated conductors are laid together, the interstices being filled with jute, *G*, and covered with two layers of close braid, *E* and *F*.

Each braid is made of No. 20 two-ply cotton thread, braided with three ends.

Double Conductor.—Double conductor is classed as: Double Conductor, Plain; Double Conductor, Silk; Double Conductor, Diving Lamp.

Double Conductor, Plain.—The center conductor is constructed as follows:

A copper conductor, *A* (Fig. 26), consisting of seven No. 22 B. & S. G. wires, six of the wires to lay around the seventh.

A layer of vulcanized rubber, *B*, to an external diameter of 0.181 of an inch.

A close braid, *C*, of No. 60 two-ply cotton thread, braided with three ends.

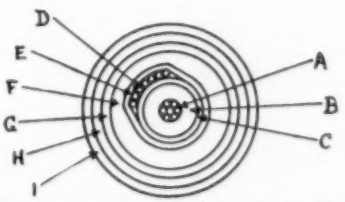

FIG. 26.—Cross-section of double conductor, plain.

The above form the core and the wires of the second conductor, *D* (seven No. 22 B. & S. G.), are laid around it over the braid concentrically and smoothly, the pitch of the lay is about 1½ inches.

Over both conductors is:

A close braid, *E*, of No. 60 two-ply cotton thread, braided with three ends.

A layer of vulcanized rubber, *F*, to an external diameter of 13/32 inch, to be vulcanized before braiding.

A layer of cotton tape, *G*, about 1/32 inch in thickness.

A close braid of No. 30 three-ply linen gilling thread braided with two ends, *H*.

A close braid, *I*, of No. 30 three-ply linen gilling thread braided with three ends.

The finished dimension is 19/32 inch.

Double Conductor, Silk.—Each conductor is constructed as follows:

A stranded copper conductor, *A* (Fig. 27), consisting of seven No. 25 B. & S. G. untinned wires, six wires to lay concentrically around the seventh.

A close braid or wrapping, *B*, No. 80 Sea Island cotton thread.

A layer of vulcanized rubber, *C*, to a diameter of 4/32 inch.

A close braid, *D*, of No. 60 two-ply cotton thread.

A close braid, *E*, made of hard-twisted olive-green silk.

Two conductors thus constructed are *twisted together* to form the finished conductor.

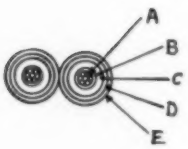

FIG. 27.

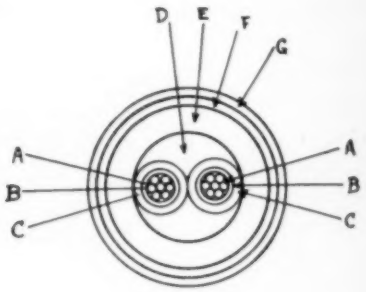

FIG. 28.

FIG. 27.—Cross-section of double conductor, silk.
FIG. 28.—Cross-section of double conductor, diving lamp.

Double Conductor, Diving Lamp.—Each conductor is constructed as follows:

A conductor, *A* (Fig. 28), consisting of seven No. 20 B. & S. G. wires, six of the wires to lay around the seventh.

A layer of pure Para rubber, *B*, rolled on, of a thickness not less than 1/64 inch.

A layer of vulcanized rubber, *C*, to an external diameter of 0.186 inch.

Two conductors thus constructed are laid up or twisted together, and filled with jute lateral, *D*, to a circular section and an external diameter of 0.372 inch. The jute is saturated with an insulating compound.

Then to be covered with:

A layer of vulcanized rubber, *E*, to diameter of 18/32 inch.

A close braid, *F*, of No. 30 three-ply linen gilling thread, braided with three ends.

A close braid, *G*, of No. 30 three-ply linen gilling thread, braided with four ends.

The finished dimensions is 22/32 inch.

Bell Wire.

Bell wire is classed as bell wire and bell cord.

Bell Wire.—Bell wire is constructed as follows:

A conductor consisting of one No. 16 B. & S. G. wire.

A layer of vulcanized rubber to a diameter of 0.113 inch.

A close braid of No. 40 two-ply cotton thread, braided with three ends to a diameter of 0.14 inch.

Bell cord, double, triple, and quadruple, consists of a twist of two, three, or four of the single wires specified for Double Conductor, Silk, and is used for wiring single, double, and triple pear push buttons. When bell cord, double, is required double conductor silk is usually used.

Cable.

Cable is classed as follows: Interior Communication Cable; Cable for Night-signalling Sets.

Interior Communication Cable.—Each unit conductor (Fig. 29) consists of seven No. 24 B. & S. G. wires, *G*, the seven grouped to approach circularity of section; the whole is wrapped with No. 80 cotton thread, *H*, to a diameter of 0.068 inch, then covered with vulcanized rubber compound, *F*, to a diameter of 0.136 inch, then braided with No. 60 white cotton thread, *E*, braided with three ends, the over-all diameter to be 0.156 inch.

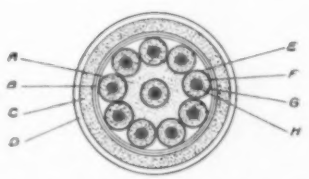

FIG. 29.—Cross-section interior communication cable.

The requisite number of unit conductors, ten in the figure, to be laid up with a twist (having been filled with jute laterals, *A*, to approach circularity of section), then covered with:

A layer of cotton tape, *B*.

A layer of vulcanized rubber, *C*.

A close braid of No. 20 two-ply cotton thread, *D*, braided with three ends, for all cables of less than twelve conductors, and of

No. 16 three-ply cotton thread, braided with four ends, for all cables of above twelve conductors.

One unit conductor in each cable of and under seven wires, and one wire in the inner and one wire in the outer layer in each cable in excess of seven wires has three adjacent black threads woven in the white braid.

DIMENSIONS OF STANDARD INTERIOR-COMMUNICATION CABLE.

Conductors.	Number of wires.				Diameter in inches.		Diameter in 32ds of an inch.	
	1st layer of core.	2d layer.	3d layer.	4th layer.	Over conductor.	Over tape.	Over vulcanized rubber.	Over braid.
3	3	..	..	..	..	.3987	17	19
4	4	..	..	..	..	.4395	18	20
5	5	..	..	..	..	.4841	20	22
6	6	..	..	..	..	.5312	21	23
7	1	6	..	..	..	.5312	21	23
8	1	7	..	..	..	.5785	22	24
9	1	8	..	..	..	.6350	25	27
10	1	9	..	..	..	.6750	26	28
11	2	9	..	..	..	.6875	26	28
12	3	9	..	..	..	.7112	27	29
13	3	10	..	..	..	.7235	28	30
14	4	10	..	..	..	.7520	29	31
15	4	11	..	..	..	.7729	30	32
16	5	11	..	..	..	.7966	31	33
17	5	12	..	..	..	.8220	31	33
18	6	12	..	..	..	.8430	32	34
19	1	6	12	..	..	.8430	32	34
20	1	6	13	..	..	.8800	33	35
21	1	7	13	..	..	.8910	33	35
22	1	8	13	..	..	.9325	35	37
24	1	8	15	..	..	.9875	37	39
26	2	9	15	..	..	1.0000	38	40
28	3	10	15	..	..	1.0360	39	41
30	4	10	16	..	..	1.0645	40	42
32	4	11	17	..	..	1.0854	41	43
34	4	12	18	..	..	1.1345	42	44
36	6	12	18	..	..	1.1562	43	45
38	1	6	12	19	..	1.19125	44	46
40	1	7	13	19	..	1.2035	45	47

UNIT CONDUCTORS (STRANDED).

Wire.		C. M.	Diameter in inches.			
B. & S.	Number of strands.		Over copper.	Over cotton wrapping.	Over vulcanized rubber.	Over braid.
24	7	2,828	.060	.068	.136	.156

Cable for Night-Signalling Sets.—Each conductor is made up of nineteen strands (*A*, Fig. 30) of No. 25 B. & S. G. wire.

The insulation is made up as follows:

First. A layer of Para rubber, *B*, 1/64 inch thick rolled on.

Second. A layer of vulcanized rubber, *C*, to a diameter of 0.257 inch.

Third. A layer of 1/32-inch thick cotton tape, *D*, lapped one-half width.

Fourth. A close braid of No. 30 three-ply linen gilling thread, *E*, braided with two ends; the diameter over braid to be 3/8 inch.

Sixteen conductors so constructed are laid up in the finished cable.

The cable is constructed as follows:

The heart of the cable consists of a continuous length of 9-thread, tarred, well-stretched hemp rope, *G*; the upper end of the heart extends beyond the end of the cable conductors and is finished with a neat, strong eye splice 3 inches in length.

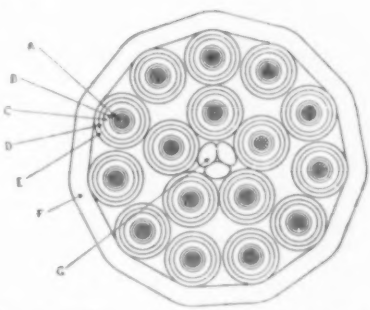

FIG. 30.—Cross-section night-signalling cable.

Around the heart are laid five of the unit conductors; the lay is spiral, with left-hand twist, and of such a pitch as will closely assemble the conductors on the heart.

On the inner lay are laid the remaining eleven unit conductors; the lay is spiral, with right-hand twist, with jute filling, and of such a twist as will closely assemble the conductors on the inner layer.

The conductors are branched out for the lamps in pairs, using adjacent conductors; the reduction caused by branching is made in a neat taper by filling in with dead wire or jute; branching is first done from the outside layer of the cable and is spaced for 12-foot distance between the lantern centers, unless otherwise directed.

The outer layer of conductors is securely hitched with marline hitches, *F*, 1 inch apart, using a six-ply flax twine of about 1/8 inch diameter; the hitching is for the entire cable length.

In order to overcome induction from the aerial of the wireless, the upper end of the cable is closely served with No. 26 B. & S. G. iron wire, for a distance of about 10 feet down, commencing 50 inches below the top of the upper lantern.

The lower, keyboard, end of the cable is fitted with a navy standard male coupling. The cable is furnished in special lengths, as required, the length being measured from the coupling to the first outlet.

Inspection of Wire.

Quantity Delivered.—The length of wire on each reel is checked by running the wire through a registering counter, somewhat on the design of the counter of navigational sounding machines.

The end of the wire is taken between the swallows of two sheaves. The upper sheave is attached permanently to its axle, on which axle is a gearing which actuates a train of wheels moving a pointer over a dial, registering in feet. The lower sheave is larger, is also attached to its axle, but the axle journals in bearings set in a movable guide which has a vertical motion against a spring; this arrangement permits of accommodating the distance between the sheaves to varying diameters of wire; the spring also holds the lower sheave up against the wire, which in turn presses firmly against the upper sheave to avoid lost motion or slipping which would invalidate the dial indication; as the wire is pulled through it is reeled up on a horizontal reel whose posts are removable, leaving the wire coiled in readiness for the tank (for insulation resistance).

Test Samples.—From each reel is cut a 5-foot sample, which is divided up into five test samples as follows:

Sample No. 1, Three Feet Long.—This sample is used for all physical tests, not included under the chemical, baking, and braid tests, and also for the determination of the conductivity of the copper conductor. As the different layers are stripped off, the following are examined into:

That the diameters of each component layer of the construction, as prescribed by the tabulation, is correct, with special reference to that over vulcanized rubber and braid; these diameters are gauged on at least three planes to test the circularity of section. In order to insure watertightness, a rubber composition gasket

is used as a packing which is designed to fit over the vulcanized layer or braid on the wire (jacket of cables); the orifice of the gasket is exactly prescribed for a particular use, and it becomes mandatory that the section be circular and the diameter over the layers which are to fit in these gaskets be exact. The diameter over the outer braid of the finished construction is also important as determining the clearance which will be available when the wire is drawn in conduits; it is economical to draw as long lengths as possible, and undue stress on the wire must be avoided to prevent rupture or stress of the components of the wire construction through stretching; cables require especial care in this respect as regards the unit conductors.

That the waterproof insulating compound has thoroughly soaked the outer braids, determined by examining the inside surface; and that the proper number of threads (ends) are used and are closely woven. The number of ends prescribed are those which assure a neat fit over the underlying construction.

That the tape is thoroughly saturated with the insulating compound, and that it is smoothly lapped one-third to one-half. Tape layers are intended to act as a binding which will assure circularity of section of the vulcanized rubber layer which is to fit the gaskets, and to insure circularity for the braid; it is important that the tape does not adhere too closely to the vulcanized rubber. Tape should be carefully examined for folds or breaks which would produce roughness or imperfection of the vulcanized rubber layer. The insulating compound used on the tape is generally a rubber compound and is tested by burning a weighed sample; the characteristics required are rather waterproofing than insulating, the insulating is prescribed as it accomplishes both.

That the layer of pure Para rubber, next to the copper conductors, is uniform, free from flaws or holes, and, if taped, that the tape laps one-half, making the surface uniform. This determination must be made by examination of the longitudinal section and interior surface as, due to vulcanization from free sulphur, the line of demarcation between the pure Para rubber layer and vulcanized rubber is seldom distinct.

When the copper conductor has been stripped of layers, any adherent rubber is dissolved off with benzine and each wire composing the strand is examined for thoroughness and evenness of tinning, when so specified.

A length of one foot of all rubber layers is carefully removed in stripping for the determination of tensile strength and elongation, a test which is made in connection with the chemical test.

Determination of Conductivity.—The sample of copper conductor is weighed, the weight being taken in grammes. Three of the unit wires composing each strand of the copper conductor are then separately tested for resistance in the X arm of a box of resistance coils arranged as a Wheatstone bridge and connected up with a Queen and Company's modification of the D'Arsonval galvanometer; the battery used is two cells (4½ volts) of an Electric Power and Storage Battery Company's accumulator. From the mean of the three resistances, and the mean of the weights of the three wires, the percentage of conductivity, as compared with that of pure copper at the temperature of 75° F., is determined by the following formula:

$$\text{Conductivity per cent} = \frac{L \times L \times 1.44268}{W \times R \times K}$$

in which L is the length of the original conductor (3 feet); W is the weight of the length of the original copper conductor; R is the mean resistance of the three wires measured; K is the temperature coefficient, generally derived from a predetermined curve, which reduces R for the temperature of 75° F. This convenient formula is derived from the metre-gramme determination of Matthiessen for copper resistance at 0° C., and is calculated for the foot-gramme at 75° F., reduced to percentage of conductivity. Results of 99 or 100 per cent are latterly not infrequent for good wire.

Sample No. 2, Six Inches Long.—This specimen is placed in an oven, which consists of a sheet-iron box covered with a non-conducting layer of asbestos wool; three steam coils inside the box vary the temperature in accordance with changes of steam pressure. A thermometer is inserted through an aperture in the top of the box. The front is provided with a glass door, through which the sample and thermometer can be observed. The temperature is raised to 95° C. At the expiration of four hours the specimen is cooled in the air and then sharply bent to a radius seven times the wire diameter; it should develop no breaks of cracks in either the braid or insulation and the compound should show no tendency to run out. The specimen is subjected to

several similar tests over an interval of three days. For twin conductor the minimum diameter is the basis of bending.

Double Conductor, Silk, and Bell Cord are not baked.

Sample No. 3, Six inches Long.—The test of this sample is for determination of the water-repellent qualities of the outside braid and the tape. The ends of the specimen are dipped into hot paraffin, the specimen is weighed and is then submerged in water for 48 hours. When taken out it is again weighed, after drying the exterior surface, and the results reduced to percentage of absorption for braid and tape by subtracting the weight of the component layers of the wire which they cover. An absorption of 15 per cent is permitted.

Silk-covered conductors are not tested for absorption, as they are not expected to be waterproof.

Sample No. 4, Six Inches Long.—This sample is tagged and retained for future reference, especially with regard to re-inspection when occasioned by rejection.

Sample No. 5, Six Inches Long.—This sample is forwarded to the chemist and is tested: First, by microscope to determine as to cotton, linen, jute, and silk; the fibers are so distinctive for each that compliance with specification is readily tested without recourse to chemical re-agents or stains except as a check in case of doubt.

Second, for determination of rubber constituents. The analysis of rubber compounds consists in determining the following:

Extractive Matter, Saponifiable Matter, Mineral Matter, Vulcanized Rubber, Sulphur and Gum.

The Extractive Matter consists of resins, free sulphur, and sulphinated products.

Saponifiable Matter consists of rubber substitute.

Mineral Matter is the ash.

The Vulcanized Rubber consists of the gum and the sulphur.

The sample to be analyzed is digested with acetone for two hours; it is then dried for about half an hour, cooled and weighed. The loss represents the extractive matter. The solution is evaporated to dryness, taken up in alcohol, and divided into two parts: one part is treated with concentrated nitric acid, allowed to digest on a steam bath, filtered, and the filtrate precipitated with barium chloride and allowed to settle over night; then filtered off and weighed, from which sulphur is calculated. This is the free

sulphur. The other part is evaporated to dryness, taken up in neutral alcohol, titrated with fiftieth normal caustic potash; this, when calculated to abietic acid, represents the resins.

The residue from the previous operation is treated with 8 per cent caustic alcoholic soda and allowed to stand for 8 hours on the water bath. The alcoholic extract is then poured off and washed well with hot water, adding a little hydrochloric acid until neutral, and then dried and weighed. This weight, deducted from the previous weight, represents the amount of substitute present in the sample. This residue is ignited in a porcelain crucible and is calculated as mineral matter.

The sum of the extractive matter, saponifiable matter, and mineral matter, subtracted from 100, denotes the percentage of vulcanized rubber.

The total sulphur is separately determined: about one gramme of the sample is weighed into a 2-inch porcelain capsule and treated with a small amount of fuming nitric acid; when the evolution of gas has ceased the capsule is filled up with fuming nitric acid and allowed to stand over night; in the morning it is evaporated almost to dryness on the water bath. The residue is neutralized with magnesia, stirring with a small platinum rod and ignited, cold water is added and dissolved in hydrochloric acid; it is now filtered and the sulphate precipitated with barium chloride. On standing over night the barium sulphate is filtered off, ignited, weighed, and calculated to sulphur. This represents the total sulphur. This sulphur, subtracted from the amount of vulcanized rubber, gives the percentage of gum. This percentage of gum represents the actual amount of chemically pure gum present; but as the Para gum contains an extractive value of its own, normally 2½ per cent, the 2½ per cent should be added to the amount of gum to determine the actual amount of gum used (to be 39 to 44 per cent fine Para).

In interpreting these results, the amount of extractive matter is the best guide to determine the quality of gum used. The evidences of regenerated rubber and rubber substitute are shown by high extractive values. If free sulphur has been found to be present it must be subtracted from the total sulphur before deducting the sulphur from the vulcanized rubber.

Asphaltum is detected in a rubber composition by treating the residue from the saponification with cold nitro-benzole for one

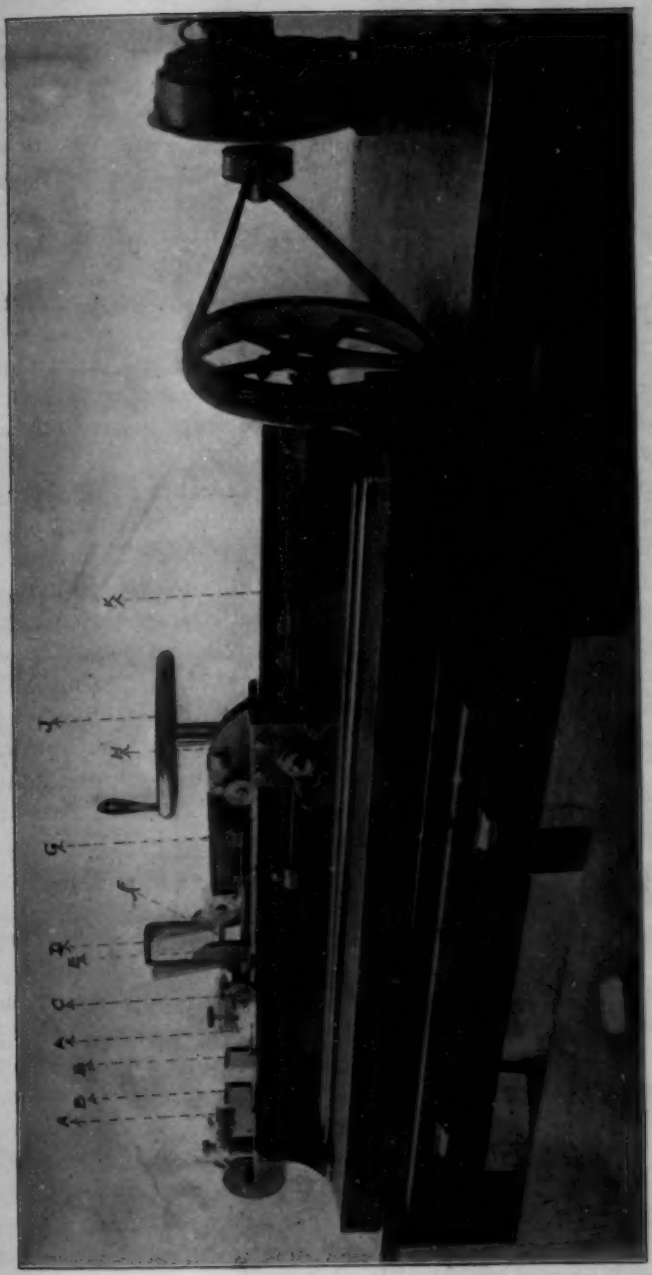

FIG. 31.—Riehlé testing machine.

95

hour. The nitro-benzole is poured off and the residue washed with ether; this residue is dried and weighed, the loss in weight representing the amount of asphaltum present. If asphaltum is present, the amount of sulphur in the asphaltum must be determined and deducted from the total sulphur, as in the case of the free sulphur. If substitutes are present, the amount of sulphur in the substitutes must also be determined and deducted from the total sulphur.

If an examination of the mineral part of the compound shows compounding with lead, the first precipitate of barium sulphate used in determining the total sulphur must be treated with hot concentrated nitric acid, washed with hot water, and the barium sulphate weighed off; this step is necessary to free the barium sulphate from lead sulphate.

Test of Tensile Strength.—The chemical test will not indicate conclusively the quality of the rubber used as regards age, that is, it will not entirely determine whether old stock, refuse, or reclaimed rubber has not been worked up in the composition, adulterations which would cause insufficient strength against stretching; to determine this the tensile strength and elongation of the vulcanized rubber layer is tested, as an adjunct to the chemical test, by the Riehle testing machine shown in Fig. 31. (A more modern type is now actually used but the details are similar.)

The pieces which were stripped from the conductivity specimens are first carefully separated from their pure Para rubber layer and cut into lengths of 5 inches by ½ inch. Three specimens are selected for the test, their specific gravity determined, and the width and thickness calipered for cross-section. A specimen is then secured in the jaws, *A*, the distances between the markers, *B*, being set for two inches; the fiducial positions of the markers, *B*, are marked in ink on the specimen. A motor belted to the wheel of the screw-shaft, *K*, is set in motion, the screw-bar giving a rate of separation of the jaws of three inches per minute. The screw-bar gears in the block, *H*, which is rigidly connected to the framing of the spring scale, *G*; the scale is similar to the circular-face scale used commercially for weighing, has a capacity of 50 pounds, and its scale registers one-tenth of a pound. The body of the spring scale travels on rollers; the tongue of the scale, *F*, is attached to the nearer jaw, this jaw being secured to a car moving on the roller, *C*. The hand wheel *J*,

is for operating the mechanism by hand but the motor is preferable as the rate of separation of the jaws can be regulated as desired and is more constant.

As the jaws separate, the markers, *B*, are kept to the original fiducial marks; a reading of the elongation in tenths of an inch is taken for every two pounds of tension shown by the spring scale. As the jaw, *A*, moves out on the roller, *C*, a wedge of sheet metal, *D*, drops down between the follower, *E*, and a lug on the car near *C*; this wedge, *D*, prevents a jar to the spring-scale mechanism when the specimen breaks or tears, locks the car for the exact point of elongation, and also locks the pointer of the spring scale for the exact tension. The mean of the elongation and tensile strength of three specimens is taken, the test results of stress being reduced to the basis of the square inch. The prescribed breaking strain per square inch is not less than 1000 pounds per square inch and the elongation is to be at least 3½ times the original length between marks (that is, at least 7 inches). A second similar sample is subjected to a test for permanent set by subjecting it to a stress of 900 pounds per square inch (9/10 of specified breaking stress) for 10 minutes; the vulcanized rubber compound should be of such a character as to return to within 50 per cent of its original length at the end of 10 minutes after release from stretch.

Continuity and Insulation Resistance.

Continuity.—The continuity of *every copper conductor* of each parcel of wire is tested by placing each separate conductor of the reel length in series with an incandescent lamp and a switchboard using the lamp voltage. It is sometimes tested by "ringing through," using the standard magneto.

It occasionally happens that the conductor has been broken in course of manufacture, the case occurs more often with interior-communication cables.

Insulation Resistance.—Each reel of wire is submerged for 24 hours in a large iron tank containing a solution of salt and water, 1½ pounds of salt to the cubic foot of water. Both ends of the wire are left suspended above the surface of the water; the layers at the ends are trimmed back, exposing the copper conductor for about one inch, and the joint and trimmed portion is covered with paraffin. At the end of 24 hours after immersion

the insulation resistance test is made by the direct-deflection method, a galvanometer being used instead of a voltmeter in this test.

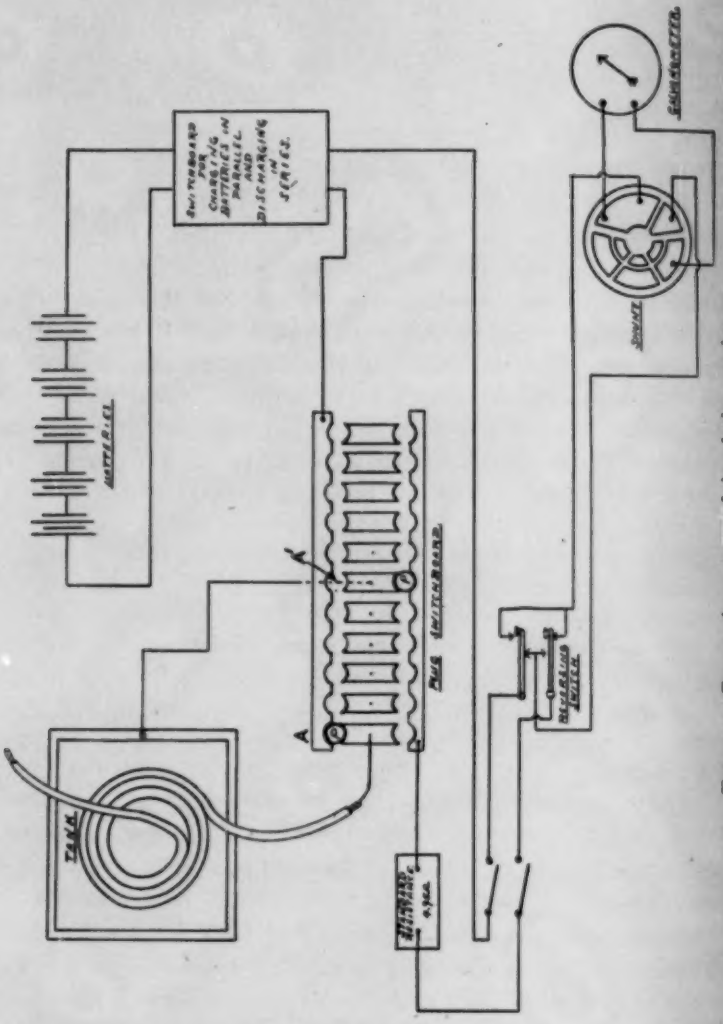

FIG. 32.—Connections test of insulation resistance.

Referring to Fig. 32, 500 volts are tapped off from a storage battery at the charging switchboard through the plug switchboard. The plug switchboard consists of two bus bars and a

series of brass blocks which can be connected to the bus bars through plugs, *P;* the middle block is connected to the metal of the tank. One end of the wire under test is connected to the block, *A,* through low-resistance leading wires which are clamped to the end of the copper conductor of the wire by a set screw. The lower bus bar is connected to a standard resistance of 4.95 megohms. The plug at *A* is first inserted at *A'* and the main switch (shown underneath the standard resistance) is closed; on closing the reversing switch a deflection is obtained due to the standard resistance alone, since the wire under test is cut out by moving *P* to *A'*. From this deflection the galvanometer constant is obtained:

Galv. Const. = 4.95 × Deflection × Multiplying power of shunt.

The plug, *P,* is now moved to *A*. On closing the main switch and reversing switch the cable is electrified and is allowed to charge for five minutes; the deflection obtained on discharge is due to the insulation resistance of the wire in series with the standard resistance, the resistance of connections being negligible in comparison. The insulation resistance in megohms per knot is then obtained from the formula:

$$\text{Ins. res.} = \frac{\text{Galv. Const.} \times \text{Length of wire in feet}}{\text{Deflection} \times 6086} - (4.95 \text{ megohms}).$$

The standard resistance is kept in series merely for convenience in retaining as permanent connections as possible.

In all finished constructions involving more than one conductor, each conductor is first tested to ground as above. The connection to the tank is then broken and both connections of Fig. 32 are led to adjacent wires of the construction to obtain the insulation resistance *between conductors,* tests being made each to each, and in the same manner as if to ground. Silk-covered wires are not put in the tank; the coils are suspended in the air and only the resistance between conductors is tested.

The prescribed insulation resistance for different types of wire is shown in the following table. (The last column is the voltage for high potential test explained later under Inspection of Generating Sets.)

Lighting wire.	Insulation resistance.	Test voltage, 30 minutes.
Up to and including:		
500,000 cm., single	1,000 megohms per knot	4,500
650,000 cm., single	900 megohms per knot	4,500
800,000 cm., single	800 megohms per knot	4,500
1,000,000 cm., single	750 megohms per knot	4,500
All twin wire:		
Between conductors	1,000 megohms per knot	3,500
From conductors to ground	1,000 megohms per knot	3,500
Double conductor.		
Plain:		
Between conductors	1,000 megohms per 1,000 feet	2,500
Each conductor to ground	1,000 megohms per 1,000 feet	3,500
Diving:		
Between conductors	1,000 megohms per 1,000 feet	3,500
Each conductor to ground	1,000 megohms per 1,000 feet	3,500
Silk	No test	5,000
Bell wire	500 megohms per 1,000 feet	1,500
Bell cord	No test	5,000
Cable.		
Interior-communication cable:		
Between conductors	1,000 megohms per 1,000 feet	1,500
Each conductor to ground	1,000 megohms per 1,000 feet	3,500
Night-signal cable:		
Conductor for	1,000 megohms per 1,000 feet	3,500
Completed cable—		
Between conductors	1,000 megohms per 1,000 feet	3,500
Cable to ground	50 megohms per length	3,500

[NOTE 7.—These minima of insulation resistances are derived from experiments on the different compositions used and, in the case of lighting wire, the empirical formula commonly used for determination in thousands of megohms per knot is that of the rectangular hyperbola:

$$xy = .742$$

x being the insulation resistance required:

y being the diameter of the copper conductor:

0.742 being the diameter of the copper conductor of a 400,000 cm. wire, for which the formula gives 1000.

The theoretical formula,

$$\text{Ins. res. per knot} = \frac{1}{2\pi L} \times \log_e \frac{D}{d},$$

in which D is the diameter over insulation and d the diameter over the copper conductor, is reduced by practical wire makers, after introducing common logarithms and the specific resistance of the rubber compounds

used in standard wire (at 72° F. for two minutes electrification), to the approximate form:

$$\text{Ins. res. per knot} = 10{,}000 \log \frac{D}{d},$$

which agrees very closely in results with that of the hyperbola above given.

These formulæ show the following results:

For	4,000 cm.,	11,594	megohms	per	knot.
"	50,000 "	2,921	"	"	"
"	100,000 "	2,044	"	"	"
"	400,000 "	1,000	"	"	"
"	650,000 "	794	"	"	"
"	800,000 "	706	"	"	"
"	1,000,000 "	620	"	"	"

As insulation resistance varies inversely as the contact surface of the rubber on the copper, wires larger than 400,000 cm. should be expected to maintain a test of about 700 megohms per knot instead of 1000. Formerly it was the custom to electrify a wire for only one minute, but a curve from experiments made at the New York Navy Yard shows that electrification of from 10 to 14 minutes give more characteristic results; the curve drops slowly after 5 minutes, and that interval has now been selected.

The effect of the voltage used for test has been mentioned, 500 volts being a desirable value.]

In the inspection of cables it is important that the wire in each layer which is specified to be covered with a braid containing white threads be so covered; the device is a necessity for connecting, tracing, and testing separate wires after installation.

CHAPTER IV.

WIRING APPLIANCES.

The general term "Wiring Appliances" is extended to include molding, conduit, insulators with their clamps, stuffing tubes, box tubes, terminal tubes, fuses, gaskets, tape, etc.; the strict interpretation is confined to devices intended for wiring connections for the control of current feed, such as junction boxes, switches, and the like.

The general term may be divided into four classes:

I. Ducts (including insulators).
II. The Box Types; usually watertight.
III. Non-watertight Types.
IV. Auxiliary Appliances.

Ducts.

Ducts afford the most convenient method of protecting lines of wiring, and are divided into two general classes in ship-wiring, molding, and conduit. The main distinction is that molding has grooves or channels made in wood, while conduit is some variety of metal or other pipe.

Molding.—Molding is divided into two classes: molding for lighting-wire, and molding for bell-wire and cables; the varieties for each class are designated by the width.

In Fig. 33 *A* is the lighting-wire molding and *B* is the bell-wire molding. *C* is an especial type of molding sometimes used for the dynamo leads; the three-gutter portion is for the positive, negative, and equalizer connecting wires which lead to the switchboard, the two-gutter portion is for the shunt-connecting wires leading to the rheostat.

Molding consists of three parts: that part containing the gutters for the wires, *D*, is called *molding;* that part upon which the molding rests, *E*, is known as the *backing strip;* and that part which covers the gutters, *F*, is the *capping*. The *backing strip* is usually ¾ inch thick; the width depends upon the number of lines of molding which are to be run over it; that is, if several lines of molding are to be run, side by side, the backing strip for those lines would be a board, ¾ inch thick, and of a width equal to the sum of the widths of the several moldings. When

bolt or rivet heads, etc., jut out more than ¾ inch, the thickness of the backing strip must be increased. Backing strip is not used if the molding is to be run over a smooth or wooden surface. All *capping* is of the same width as the molding, and is ⅜ inch thick; to prevent warping it must be screwed to the side walls of the molding and not to the center wall.

Both molding and backing strip are made of thoroughly seasoned white pine; they are coated with white-lead paint after being fitted and before securing in place. When run over hard-wood

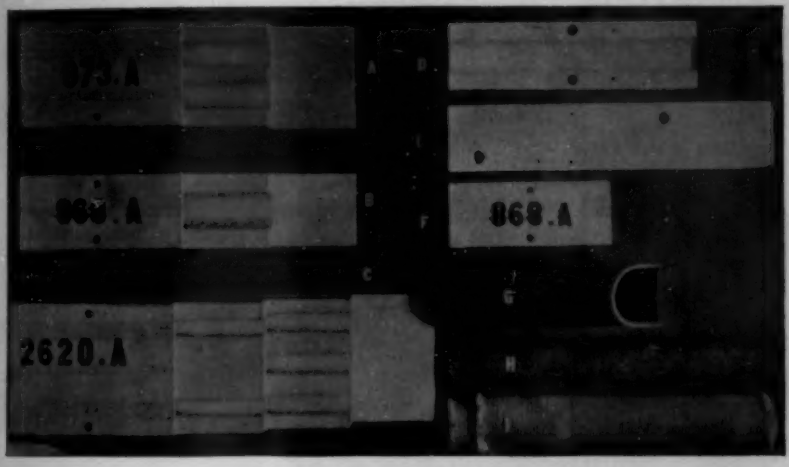

FIG. 33.—Types of ducts.

surfaces all parts are of the same material and finish as the surrounding wood work.

The following are the standard dimensions of lighting-wire molding; bottoms of gutters to be semicircular in section:

For all feeders and wires of 60088 c. m. to 124928 c. m., inclusive—3 inches wide, 1½ inch deep, including capping; to have two gutters each ¾ inch wide and ¾ inch deep, gutter separated by a ¾-inch wall; outside walls to be ⅜ inch.

For wires below 60088 c. m.—¾ inch wide, 1⅜ inches deep, including capping; to have two gutters, each ⅝ inch wide and ⅝ inch deep, gutters separated by a ¾-inch wall; outside walls to be ⅜ inch thick.

The following table shows the standard dimensions of molding

for bell wire; bottoms of gutters to be semicircular in cross-section:

Type.	Width, inch.	Depth, Inc. Capping, inch.	Cutter inch.	Side Walls, inch.
2¼-inch	2¼	1¾	1	⅝
2½-inch	2½	2	1¼	⅝
2¾-inch	2¾	2⅛	1⅜	11/16

The use of molding is now generally restricted to the repair of installations originally constructed on the method. It is practically prohibited in the present policy of eliminating all wood from the permanent construction of the ship to minimize the risk of fire in action.

As a system it is inconvenient and objectionable for a variety of reasons, the chief of which are the following:

The large number of holes to be drilled and tapped, every 12 inches of length, to secure the backing strip. The drilling of beams for a passage for the wire, detracting from the beam strength; each hole drilled must also be carefully bushed with hard rubber. Changes of direction, or crosses, must be made by mitered joints, necessitating laborious and slow joiner work. No watertightness is assured except at connections, the mitered joints, capping, and fit at beams, leak; as the insulation afforded depends entirely upon keeping the molding dry, leakages through deck tubes readily introduces salt water. Many lengths of molding have been taken from ships which were charred through by a neighboring steam pipe, bake oven, galley, etc.; the carbon formed is not only a good conductor but is very hygroscopic; fireproofed woods are usually poor insulators, and corrode metal fastenings.

Molding is only fairly strong; it affords little protection to the wire from rough usage in fire-rooms or coal-bunkers, as it is easily torn down; it must follow the metal surfaces and cannot be run "flying." Where piping or some particular device requires much space up and down an engine- or fire-room bulkhead, the wiring must be led through to the opposite side, and generally into a coal-bunker; in these fire-room and coal-bunker locations, also subjected to clouds of dust and ashes, the use of molding has proved inadmissible.

Molding is sometimes permitted in quarters which are outside the watertight system of the ship; as the limits of the watertight system are generally defined to include all the ship construc-

tion below the stability (main) deck the use would be restricted to the upper deck cabins or wardrooms; it is also seen on some constructions where the wiring is run on insulators.

Conduit.—The types of conduit specified are: Steel, enameled; brass, enameled, flexible. Specimens of the first and third are shown in Fig. 33. There are in use, also, the *iron armored* or *lined conduit,* and a *flexible* type consisting of covered rubber hose.

Steel, enameled, and *brass, enameled,* conduit (*G,* Fig. 33) conform in their metal construction to the dimensions for commercially standard steam, gas, and water pipes. On the dimensions of the following table 0.02 of an inch is allowed for manufacturing and loss of thickness in cleaning:

I. P. S.	Outside diameter.	Thickness of wall.	Inside diameter.	No. of threads per inch.
Inches	Inches.	Inches.	Inches.	
½	0.840	0.110	0.620	14
¾	1.050	0.115	0.820	14
1	1.315	0.135	1.045	11½
1¼	1.660	0.140	1.380	11½
1½	1.900	0.145	1.610	11½

Steel conduit is bought in lengths of 10 feet; brass in lengths of 12 feet.

Each length is threaded with a right-handed pipe-thread at each end, and one end of each length is supplied with a standard right-handed coupling of the same metal as the conduit length to which it is attached.

The interior surface of enameled conduit should be smooth and free from burs or fins; the bores must not be diminished in cutting; all ends should be faced square and the inner edges slightly beveled. The enamel is to be of not less than three coats, and is baked on, inside and out; Sabin's baking enamel is preferred for the purpose.

Steel conduit is used for the general installation throughout the ship. Brass conduit is used, generally speaking, in locations where the use of steel is undesirable, such as magazines, shell-rooms, ammunition-rooms, including their connections and approaches (*steel is now commonly used, however*); about (if near) compasses, especially the standard compass.

Iron-armored (lined) conduit consists of a wrought-iron pipe lined with a bitumenized paper tube 1/16 inch in thickness; a

light cotton sheeting lining is sometimes placed between the pipe and the paper.

The type is not now carried in stock and is not replaced.

Flexible conduit (H, Fig. 33) consists of a spiral of insulated fiber over which is wound a heavy rubber friction tape; both are covered with a continuous woven jacket of cotton which is saturated with insulating compound and sprinkled with powdered mica. The particulars are tabulated as follows:

Inside diameter. Inches.	Outside diameter. Inches.	Feet to coil.	Pounds per foot.
½	¾	200	0.125
⅝	⅞	200	0.140
¾	1	150	0.175
1	1¼	100	0.250
1¼	1½	100	0.280

For repairs on board ship 1½-inch hose answers very well; the best for the purpose is the double cotton-jacketed hose (*I*, Fig. 33).

The use of flexible conduit is confined to runs of wiring where the conduit will be subjected to a twisting strain, such as those leading to turret lights and apparatus. It is rarely used as the twisting can be accommodated by leading between boxes on the turret spindle, in other cases jacketed hose is preferable. In latest practice flexible conduit has entirely disappeared.

Conduit Fittings.—The fittings necessary to connect up a line of conduit conform in size to the conduits with which they are to be used; those for steel, enameled, conduit, unless specifically prescribed, are of steel, wrought iron, malleable iron, or cast iron, accordingly as the particular material is used in commercial practice for commercially standard pipes; those for brass, enameled, conduit are of the "beaded malleable" pattern.

Elbows (*A*, Fig. 34) are made of conduit, are bent 90°, in equal legs, and pipe-threaded at each end, *externally*.

I. P. S. Inches.	Radius outside. Inches.	To fit in square of side. Inches.
½	5 to 5½	7¼
¾	5½ to 6	8½
1	6 to 7	10
1¼	7½ to 8	11⅜
1½	9 to 10	13⅝

Outlet elbows, 90°, are constructed of the same material as *elbows* and are similar in appearance to those used for steam pipes; they are threaded *internally,* and are of the following sizes: Iron-pipe size, ½ inch, ¾ inch, 1 inch, 1¼ inch.

Outlet elbows, 45°, differ from *outlet elbows,* 90°, only in the angle of the bend, and are of the same iron-pipe sizes.

Long elbows (*B,* Fig. 34) are made of conduit and are bent 90° in unequal legs, externally pipe-threaded at each end.

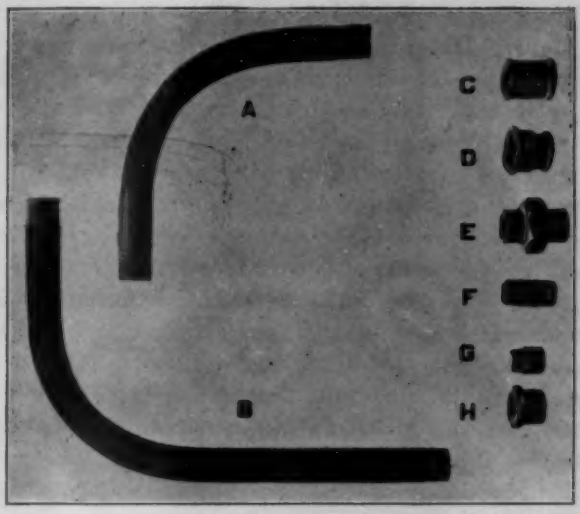

FIG. 34.—Types of conduit fittings.

I. P. S. Inches.	Radius outside. Inches.	To fit in rectangle side. Inches.
½	5 to 5½	10⅞ by 7¼
¾	5½ to 6	12 by 8½
1	6 to 7	13¼ by 10
1¼	7½ to 8	15⅝ by 11⅜
1½	9 to 10	17⅞ by 13⅝

Couplings, plain (*C,* Fig. 34), are the pipe couplings to connect up the lengths of conduit and are continuously threaded internally. The sizes are: Iron pipe size, ½ inch, ¾ inch, 1 inch, 1¼ inch, 1½ inch.

The couplings may be *right-handed,* the thread running continuously from end to end, used for the general use of connecting up a line of pipe, and in which the coupling is first screwed to

one length and the next length screwed into the coupling; or *right- and left-handed*, the thread being cut *right-handed* at one end and *left-handed* at the other, used for connecting up lengths of piping where it may be desirable to open up without taking down the line from either or both ends. The difference in use between the right and left coupling and a union is that unions are used when the pipe cannot be drawn (sprung) back, right and left couplings necessitate a separation of the ends by a full inch.

Couplings, reducing (*D*, Fig. 34), are similar to those used with commercial pipe, and are used when a change in size of pipe is desirable; they are threaded right-handedly, internally, and accomplish the following changes:

Iron pipe size: ¾ inch to ½ inch, 1 inch to ¾ inch, 1¼ inch to 1 inch, 1½ inch to 1¼ inch.

Unions (*E*, Fig. 34) are similar to commercial pipe unions, but the lip is ground off to facilitate springing apart the two lengths of conduit. They are used for separating a line of piping in lieu of *right- and left-handed* couplings in locations where the pipe cannot be forced back and the ends must be separated across the pipe end faces.

Nipples (*F*, Fig. 34) are made of enameled conduit and are externally threaded at each end; there are occasions requiring threading for the entire length. They are used as the connection of the conduit to various devices and as fitting pieces in finishing runs.

Both ends R. H. threads			One end R. H. and one L. H.		
	Lengths.			Lengths.	
I. P. S. Inches.	Short.	Long.	I. P. S. Inches.	Short.	Long.
½	1½	3½	½	1½	3½
¾	2	3½	¾	2	3½
1	2	4	1	2	4
1¼	2½	4½	1¼	2½	4½
1½	2½	4½	1½	2½	4½

Plugs (*G*, Fig. 34) are similar to commercial pipe plugs, and are right-handed; the sizes are: Iron-pipe size, ½ inch, ¾ inch, 1 inch, 1¼ inch, 1½ inch.

They are used for closing up the unused openings of appliances.

Bushes (*H*, Fig. 34) are similar to commercial pipe bushes.

The standard sizes are: Iron-pipe size, ¾ inch to ½ inch, 1 inch to ¾ inch, 1¼ inch to 1 inch, 1½ inch to 1¼ inch..

They are used where a smaller pipe is to be fitted into a fitting already tapped for a larger; they differ from a reducing coupling in that they are threaded both externally and internally.

Conduit should be used exclusively for ducts. Some of its advantages are:

The time and labor of installation is limited to drilling, without tapping, for hangers at beams only, or for straps at four- or five-foot intervals along flat surfaces, such as bulkheads, decks, etc.; changes of direction are made by bends or elbows which, except in long bends, require no fastening; one length joins the next through the commercial coupling. The drilled holes in beams and flat surfaces detract less from the metal strength than those for molding. It is watertight from the nature of the continuity of pipe joints and the screw joints at boxes, fixtures, etc. It is strong; it affords ample protection to the wiring where exposed to rough usage; it can be utilized as the pendant or support of a box or fixture; it can be bent clear of apparatus which interferes; it is fireproof; it affords good insulation as both pipe surfaces are covered with a good insulating material. The principal objection to conduit is its weight. In regard to the statement as to insulation, a qualification must be applied that the conduit be drained and dry; experiments show that if the dry enamel layer be examined with an exploring wire it will easily stand 2000 volts and the insulation resistance be high. If one end of a piece of conduit be embedded in paraffin and the tube be filled with salt or acidulated water, on inserting a wire into the water and again touching the metal of the conduit a low resistance or dead ground will result, showing that however well the enamel be put on, there are still minute interstices which affect or vitiate the insulating properties.

Insulators.—Insulators are made of glazed porcelain and a number, one for each wire run, are assembled together as shown in *A*, Fig. 35, which is the especial arrangement for lines of the larger sizes of wiring which are to be run along flat surfaces such as under decks and on bulkheads. The blocks of this assembly are square, in two parts, and are scored at each end for the securing bolts. The securing bolts are riveted into a base strip of bar metal whose width is the thickness of the insulator block, and

their outer end is threaded for the nut which is set up on a round washer. Between the blocks and the metal base, and along the outer surface of the blocks, *and underneath the washers, is placed a strip of 1/16-inch cloth-insertion sheet-rubber packing,* which serves as a cushion against shock and gives a more even distribution of stress. At either end of the block assembly a post support is riveted to the metal base strip and finished at the outer end with thread, nut, and washer. The surface over which the base strip is to rest is tapped for two bolts which secure the assembly in place.

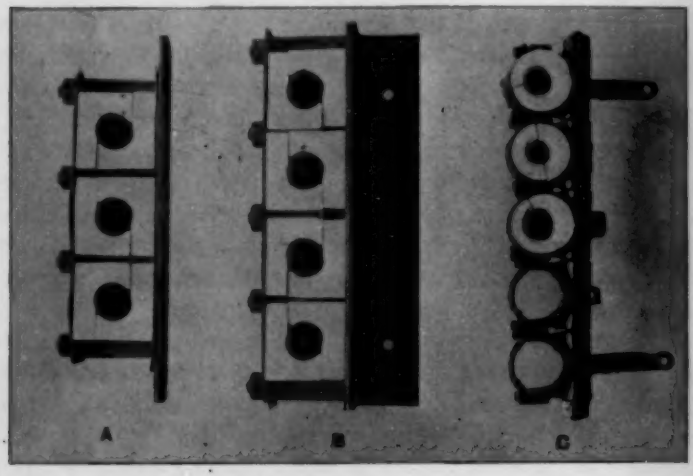

FIG. 35.—Methods of insulator installation.

B (Fig. 35) shows another assembly of square insulators erected on an angle bar; this arrangement is used where the assembly is to attach to the angle side of bulkheads, beams, or projections which afford a flat surface for bolting.

C (Fig. 35) shows an assembly of round insulators, a convenient arrangement for attaching to beams, etc. One hanger has a flat surface for working next a single bulb beam, the other is curved and is of the type for working over double bulb beams; for channel beams a flat strap only is necessary. This assembly consists of a bar threaded at each end, over which the sleeves carrying the insulators and hangers are slipped, the assembly being set up by a nut and washer at the ends of the bar. The

strap for holding the insulator in the sleeve is divided, the insulator being secured by a flanged-containing strap which is set up on each side by a screw tapping into the sleeve.

As the wire is strung along on the insulators it is left uncovered except in exposed places, where it is sometimes covered by a galvanized sheet-iron cover, bent to the dimensions rectangularly, flanged and secured by screws; the different lengths of covering are not fastened together, to facilitate removal.

The chief advantage of running wire on insulators is the saving of weight and cost as compared with either conduit or molding. If a sheet metal covering is provided, it is only used where the wire is especially exposed to mechanical injury. The method would not suffice for fire and engine rooms, store-rooms, or in fact any location under the protective deck, except wing pas-

FIG. 36.—Feeder junction box for conduit.

sages, tiller or steering rooms and sections of a platform deck; above the protective deck it is not advisable, except perhaps in quarters, owing to the likelihood of injury to the wire from gun gear, etc., and particularly from thoughtless handling which would stretch the wire or break its insulation. The use of sheet metal covering is probably unsanitary, by reason of the lodgement of dust and coal dirt, and as forming a retreat for vermin, especially that ship-pest, cock-roaches.

Box Types

The use of boxes arises from the necessity of protecting, watertighting, and fireproofing circuit connections, and box types for other than interior communication lines receive their name from the particular method of connection desired as determined by the interior fitting which the box encloses.

All boxes consist of two parts, the *box proper* and an *interior fitting*.

The Box Proper.—That for conduit (Fig. 36) consists of a

cast composition shell and a cover. The sides and ends of the shell are reinforced by bosses, cast in one with the shell, which are drilled and tapped for the size of conduit appropriate to the size of the wire which is to be led in; the extra thickness of the bosses gives the length of thread required for a strong, good joint.

On the inner bottom of the shell are cast small bosses which are tapped for the screws which secure the interior fitting in place. To insulate the interior fitting and screws, if loosened, from the metal of the shell, the interior of the shell should be painted with Sabin's enamel ("Sabined"); a sheet of mica, 25 mils thick, and of slightly greater dimensions than the insulating block of the interior fitting, is fitted over the bottom bosses; the mica also affords a slight cushioning effect against shock, and affords a long surface of insulation.

FIG. 37.—Feeder junction box for molding.

The outer edges of the shell are tapped for the prescribed number of screws which will hold the cover securely without warping.

In the box walls are drilled and tapped the screw wells, in which are driven the screws which secure the completed appliance at its location in the ship. The nature of the pipe assembly is sufficient in most cases to hold the box in position without the screws in the screw wells; *to preserve watertightness, the screw well masses are never drilled unless the appliance must be secured by the screws.*

For installation where molding is the duct the type of box for similar use as Fig. 36) colloquially known as the "Navy Standard Box" is that shown in Fig. 37. The difference is that stuffing tubes are inserted at the sides and ends of the box in place of the bosses shown for the conduit box (Fig. 36). The stuffing tubes are threaded for their entire length and are screwed

into the wall of the box and braised. On the outer end of the stuffing tube is a gland whose office is to set up the conical rubber gasket which packs the wire watertight; the stuffing tubes are reamed to take the conical shape of the gasket, and inside the gland is a small brass washer ring *without which it would be impracticable to turn the gland against the friction of the gasket.* In other details the box for molding and the box for conduit are alike and both types are made for all the varieties; the covers are identical.

The box cover is sawed out of sheet brass. The screw holes are drilled by jig. The cover is cut for the apertures adapted to the particular name of box. The whole of the inner side of the cover is lined with cloth insertion sheet rubber packing, cemented on to prevent stripping when the cover is removed. The packing takes on the box edges and closes the joint watertight.

The Interior Fitting.—While each type of box appliance has an interior fitting peculiar to itself, the following are general features common to all interior fittings (except those for interior communication lines).

I. The insulating block on which the circuit connections are assembled is made of vitreous, unglazed porcelain.

II. The interior fittings of all boxes of the *same name* whether for molding or conduit are identical.

III. All current carrying parts of interior fittings are of copper (usually stampings) of 96 per cent conductivity.

IV. All current carrying parts must be exposed and not embedded in the porcelain.

The few exceptions to these general rules are noted under the respective cases.

The names of the different types of box on other than interior communication lines are:

Junction box.
Distribution box.
Switch.
Receptacle.
Switch and receptacle.

The Junction Box.

This type, commercially known as a cut-out, affords the means of tapping off current from the feeders leading from the switchboard to the mains and sub-mains, or from these latter to the branches which feed the outlets for lights, etc.

There are four classes of junction boxes:

The Feeder Junction Box (F. J. B.).

The Main Junction Box (M. J. B.).

The 4-Way Junction Box, or Branch Junction Box, 4-Way (B. J. B. 4).

The 3-Way Junction Box, or Branch Junction Box, 3-Way (B. J. B. 3).

All junction box interior fittings have their porcelains of dimensions, least, 3 9/16 by 1 13/16 by ½ inch; the clearance holes for securing by No. 6 screws to the bosses in the bottom of the box are 3¼ inches between centers. The rule previously to 1902 was 3⅛ inches; the new rule is established in order to have all porcelains interchangeable, those for conduit boxes having been established at 3¼ inches. The old type of porcelain (3⅛) can be used on a 3¼-inch center by slotting away.

All current carrying parts of the interior fitting which are of opposite polarity are to be separated from each other and from the walls of the box by at least ⅛ inch.

Feeder Junction Box.—Feeder junction boxes are for tapping off current from the feeders leading from the switchboard to mains and sub-mains only and are always made three-way, one single (or double) entrance and one single (or double) outlet for the feeder at the ends, and an outlet for the main, or sub-main, at the side.

There are two sizes of standard conduit feeder box; one which is known as Feeder Junction Box for Double Conduit, and to be installed when the wire size of the feeder is above 60,000 cm. and up to 150,000 cm.; the other when the wire size is 60,000 cm. (30,000 cm. for twin conductor) or under; the governing cause of difference in type being the number of conduits necessary for the wire size of the feeder, two conduits for the larger sizes and one for the smaller.

Figure 36 shows the smaller size of box for conduit work. The larger differs in having two bosses on the ends, one for each of the legs of the feeder, positive and negative; small size

wires can be run in one conduit, tapping into the smaller size box. The screw wells are tapped near the corners of the box and are sunk into the walls without masses. The cover is secured by six screws, one of which takes the chain of the screw cap.

The screw cap is lined with cloth insertion sheet rubber packing cemented to the inner side of the top, and is recessed for the wrench; the chain is held by a round-head-rivet post.

The interior fitting is a double-pole, single-branch block rectangular in shape.

One through circuit connection is led straight, the other is bent in to avoid the two side connections, all are secured to the porcelain by screws whose bottom ends are in recesses of the block. In one with each connector and side connector is a vertical

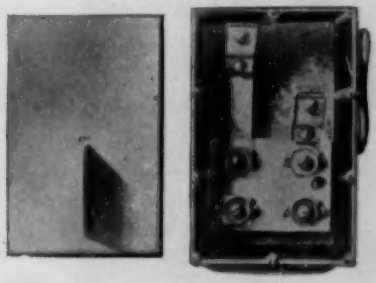

FIG. 38.—Special feeder junction box, conduit.

flanged projection on which rests a mica cup; the office of the cup is to prevent the spreading of the metal when a fuse blows, the cup protecting all of the fitting except the fuses and their contact screws. Only the side leads are fused, that is, there is no break in the feeder line. The fuses are of the copper tipped commercial type and bent as shown.

The two small copper connectors shown at the top of the figure are supplied to bridge across the fuse gap, to make through connections to the main or sub-main, when the branched wire size is to remain the same and does not require fusing, or when a sharp branch in a feeder line is to be made for which pipe bends will not answer. The copper connectors are secured to the fuse contact screws; the fuse and mica cup are then omitted. The wires are secured to the connectors by a clamping, binding strap with recess in both strap and connector.

Special Feeder Junction Box, or Feeder Box for large currents.

This type, shown in Fig. 38, is for use on heavy power circuits carrying from 400 to 500 amperes. It is much larger than other types of feeder box and has a large boss at one end, and two on each side near the end, to be tapped for leading in the wiring. The bottom of the box is covered with ⅛-inch micanite as insulation to the interior fitting.

The interior fitting block of porcelain is held to bosses on the interior bottom of the box by two screws, and to the block are secured four current carrying parts of copper—ordinarily of cast copper—having a sufficient cross-sectional area for carrying 450 to 500 amperes; the two contacts, near the leading in end of the box are copper blocks, secured to the porcelain by screws, and having binding straps for securing the wire; the other two contacts are longer connectors and curved that the wiring may pass well clear when entering to pass through the side bosses. The two sets of contacts are separated by one inch and arrangement is afforded for bridging the gap by a heavy (dynamo type of) fuse. To the inside cover of the box is secured a micanite plate which extends down between the fuses of the box to prevent arcing across. The cover is lined with cloth insertion sheet rubber packing.

[NOTE 8.—Micanite is a term used commercially for assemblages of mica in cement, it being impracticable to obtain mica in requisite thickness. One method of construction is to stamp out thin sheets of mica into convenient shapes and area, these are then built up with cement and pressed into a slab of desired thickness which can be cut or machined. The construction does not absorb moisture and is but slightly affected by oil, giving good insulating properties.]

Search-Light, or Main Junction Box.—This box is rarely used. It was intended as a through connection, to avoid splicing, in a long feeder line when the feeder wire had to be cut by reason of mechanical difficulties or probable injury in drawing; pulling sleeves obviate cutting even the longest feeder and the small carrying capacity of the box renders it inadvisable for the purpose. The box has sometimes been used on a search-light line for connecting in the search-light leads, but it is not necessary, except in the cases of alterations where a detour is made, necessitating the insertion of an extra length of conductor.

The conduit type is shown in Fig. 39. The box is similar to the feeder box but without a side boss.

The cover is without opening and held by six screws.

The interior fitting has two through connectors with binding straps at either end.

Branch Junction Box.—The branch junction box, 4-way or 3-way, is for tapping off current from mains or sub-mains to

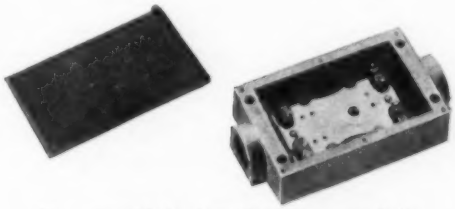

FIG. 39.—Main junction box, conduit.

the branches leading to outlets for lights, etc., only. The wires of the mains (or sub-mains) are led in at the ends and the branches led in at the side; if it is necessary to branch in on both sides a 4-way box is installed, if on one side only, a 3-way. It is intended that the side leads shall be for single wires of not greater size than No. 14 B. & S. G. (4017 cm.).

The conduit, 4-way type, is shown in Fig. 40. The 3-way

FIG. 40.—4-way branch junction box, conduit.

differs in having a boss on but one side instead of the two sides as shown.

The cover and wrench are the same as for the smaller size of Feeder Box; the screw wells are similar.

The interior fitting has two through connectors for the wire main with binding straps at each end. The side connectors are run across the block so that either or both sides may be branched.

On each through and side connection is a vertical to which is screwed a clip, protected by a U-shaped guard, the clip and guard assembled on the same screw. Into these clips are pressed the glass tube fuses for the branches. The cross-section of the current carrying parts is 30,000 cm. The clips are of phosphor bronze.

Distribution Box.—The object of the distribution box is to avoid the installation of so many branch junction boxes on a main in those locations (such as fire and engine rooms) where it is practicable to distribute to a number of outlets in nearby

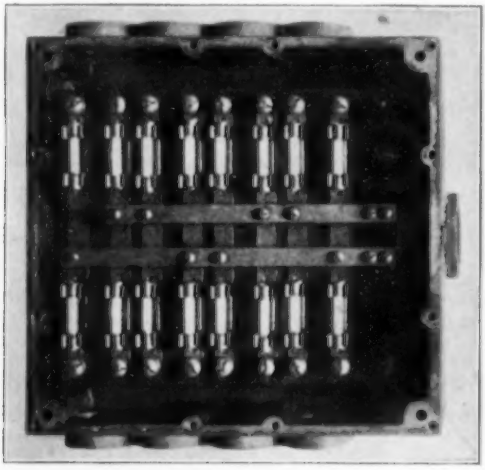

FIG. 41.—8-way distribution box (cover not shown).

locations from one central point. The distribution box collects these various branches into one box and thus simplifies access to connections and for fusing.

Distribution boxes are classed by their number of branches into two types, the 8-way and the 12-way box, the difference in construction being mainly that of length.

The boxes have usually been installed at the end of a main only, but a through run is now practiced, by casting a boss on both ends.

The 8-way box is shown in Fig. 41.

The end boss (a boss in each end in latest designs) is tapped for one-inch conduit to carry in a maximum wire size of 30,000

cm. conductor (usually twin conductors) for the main, the side taps—4 each side—are for ½-inch conduit for a maximum wire size of 4107 cm. twin conductor. The box is secured, if necessary, through four screw wells, in masses, in the corners. In the bottom of the box are four tapped bosses for the screws securing the interior fitting.

The cover is secured with twelve screws and is cut, for an opening by two plates, hinged together and held to the cover by screws; the plates are lined with cloth-insertion sheet-rubber packing, cemented on.

The interior fitting consists of a slate panel, on which are installed two copper bus bars of 30,000 cm. cross- section, leading to the end boss of the box, and ending in two contact screws which secure the binding plates for the wires of the main. Extending towards the sides of the box, and secured to the bus bars, are eight copper connectors for feeding the branches; on the outer edge of the slate base, across the fuse gap, are other copper connectors with contact screws for the branch wires; both sets of connectors are fitted with clips and guards identical with those used in the branch junction boxes. The fuse gaps are bridged with the standard glass-tube fuses.

In assembling, an oil-filled, hard wood block is placed between the slate base and the bottom bosses of the block.

The type of box has the disadvantage that the branch taps are so close together that the conduit must be bent to accommodate the individual switch boxes which are grouped near the distribution box.

Switches.

There are five types of switches (and one special switch) of which all except the 5-ampere are double-pole; their office is to make or break, cut in or cut out, the electrical supply of the lines which they control.

100-Ampere Double-Pole Switch.—This heavy switch is installed on feeder lines, on inter-connections between feeders and on search-light leads at the base of the projector, when the switch is not self-contained. The conduit type is shown in Fig. 42.

The box has a boss at each end only, capable of taking a conduit of 1½-inch pipe size. Four screw-well masses are provided at the corners.

In the bottom of the box are two bosses for securing the interior fitting.

The cover is pierced at the center for the tube forming the entrance for the switch handle shown; the entrance is closed at other times by the standard screw cap.

The interior fitting has a connector at each corner, one end of which is fitted with a binding strap for the entering wires; the other end is bent in towards the center and ends in a tongue which can be caught between the clip plates on the switch barrel, embodying the general principle of a knife switch at each tongue. Two tongues, diagonally opposite, are bent down into the recess of the block to separate the clip plates of opposite polarity by one-half inch.

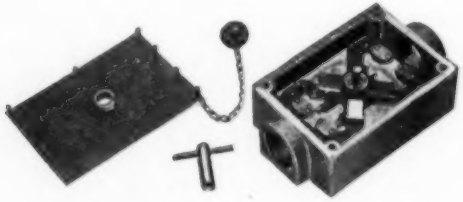

FIG. 42.—100-ampere switch, conduit.

The switch barrel assembly consists of a central steel stem fitting in a square base, the base being secured on the bottom of the block by a nut. On the shoulder of the square base is slipped a hard rubber insulating washer, above which are the lower set of clip plates, separated from each other by a copper washer $\frac{1}{8}$ inch thick. Above this pair of clip plates is a second set of same construction separated from the former by a hard-rubber washer $\frac{1}{4}$ inch thick. A hard-rubber washer at the top and a brass follower, secured by four through screws, completes the assembly.

The switch stem is insulated from current carrying parts by hard-rubber bushings.

The switch is made quick-break, to shorten the time interval of arcing, by two steel springs, bearing against brass plates, sunk in deep slots in the block.

The clip plates cross the fitting diagonally, and hence the polarity of corresponding wires at the two ends of the box will be different, or the polarity will be "crossed" in the box.

The switch is turned by a through pin on the switch stem which fits a corresponding score on the base of the hollow stem switch handle.

50-Ampere Switch, Double-Pole, Single Throw.—This large switch replaces the 100-ampere switch when a current of about 50 amperes is to be the maximum to be carried on the main. The conduit type is shown in Fig. 43.

The box has four screw well masses at the corners and end bosses. The cover is cut in the center for the switch handle and closed with the standard cap.

The interior fitting is a modification of that for the 100-ampere switch and crosses the polarity. Two of the four corner connectors are short and are bent down into the block recess, with a tongue to take between the clip plates at this end, and binding

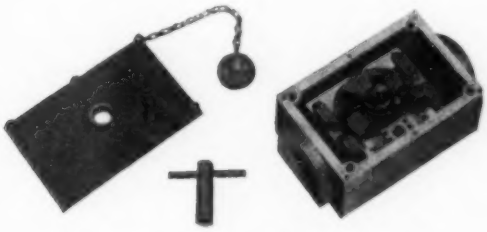

FIG. 43.—50-ampere switch, conduit.

straps at the other. Two connectors are long with binding straps but have, instead of tongues, a straight copper connector ending in a punched washer and which forms part of the switch barrel assembly.

The stem of the switch barrel is similar to that of the 100-ampere switch, the square base and steel spring, which make the quick-break, being smaller. On the shoulder of the square base is an insulating hard-rubber ring, above which is placed one of the lower clip plates, next come the washer ends of the long connectors, then the second of the lower clip plates; each clip plate is made in two leaves to reduce stiffness. The upper clip plates are similar to the lower and are separated from them by a porcelain washer ¼ inch thick. A hard-rubber washer and a copper follower completes the assembly. The switch handle and through pin are the same as for the 100-ampere.

The punchings in the washer ends of the long connections

provide collars in which the barrel turns and which secure it in place. Stops on these washers limit the throw of the clip plates.

50-Ampere Switch, Double-Pole, Double-Throw.—This switch, commonly known as the Transfer Switch, is a modification of the 50-ampere, single-throw, switch. It is installed to connect to a main carrying about 50-amperes when the main is to be fed from either the lighting or battle circuits (such as a main for signals, running lights, etc.) and is to be connected to both. The conduit type is shown in Fig. 44.

The box has a boss on one side but is otherwise similar to that for the 50-ampere, single-throw.

There are four corner connectors in the interior fitting which are similar to the short connectors of the 50-ampere, single-

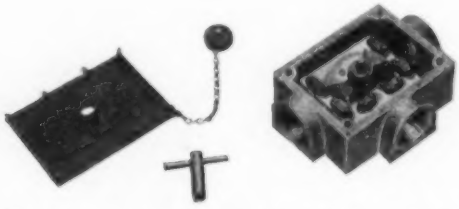

FIG. 44.—50-ampere transfer switch, conduit.

throw, switch. The two sets of two-leaf clip plates and the switch barrel are assembled similarly to those of the 50-ampere, single-throw, except that, instead of the long connectors, there are two side connectors with binding straps which have their end washer rings assembled in similarly to those of the long connectors; the washer rings have no stops and the clip plates can be swung completely around. The polarity is crossed in the connections.

Special Switch, Double-pole, Double-throw.—This large switch, shown in Fig. 45, is not carried in stock. It is a transfer switch designed to carry the heavy load of 800 amperes for use in transferring power loads for the 12-inch or 13-inch turrets from the circuits of the forward to the after dynamo room and *vice versa;* the small number used in any installation are made up as required.

The box is a built-up box of ⅛-inch galvanized sheet iron flanged at the lower end for securing to a bottom plate of iron

18¾ inches x 14⅛ inches x 5/16 inches thick, and provided with a hinged cover and a hasp for a padlock. The side of the box in the wake of the terminals has openings sufficiently large to admit the large wires.

All parts of the switch proper are of hard drawn copper; pins are of phosphor bronze; and screws and washers of brass.

Overall dimensions of the box are 18¾ inches x 14½ inches x 11 inches (high).

The poles of the switch are made up of two blades each, 2 inches by 7⅜ inches by 7/32 inch, secured to hinge posts, and to blade caps which are secured to a hard rubber yoke. On either side of the yoke is a handle at right angles to the blade of the switch. There are two clips per blade, let in and brazed to

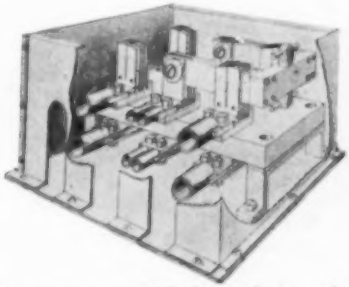

FIG. 45.—800-ampere special (transfer) switch, conduit.

foot-pieces; there is a separating piece between the clips, which acts as a stop for the blades. The foot pieces are mounted on a slate base and secured from the under side with two brass machine screws.

The slate base is secured through two strips of sheet rubber packing to two wrought-iron straps; these straps are bent into an inverted U-shape, and secured to the bottom plate of the box by hexagonal brass tap bolts.

The foot-pieces for one pole of the switch are slotted to a depth of 1 3/16 inches to receive the shanks of one set of terminals; the foot-pieces for the other pole of the switch are connected to busses located below the slate base. These busses are made in two pieces, separated from the slate base and from each other, and are secured to the studs by hexagonal nuts. The shanks of another set of terminals at the other end of the busses act as separating pieces.

The terminals are located on one side of the box; the large end terminals are for the bus wires from either distribution room, and the four small center terminals are for the circuit leads around the turret.

25-Ampere Switch, Double-pole.—This snap switch is a line switch for mains or leads not expected to carry more than 25 amperes. The conduit type is shown in Fig. 46.

Four screw well masses are located in the box ends inside of the holes for the cover screws. There is but one boss at each end.

The cover is held by four screws and is cut for the entrance of the switch handle, the entrance being closed by a standard cap. The entrance is off the box center.

FIG. 46.—25-ampere switch, conduit.

The switch stem of the interior fitting extends up through the block and switch barrel; on its lower end is riveted a brass plate carrying diametrically opposite pins on which small brass rollers journal; the rollers run on a brass ratchet in the bottom of the porcelain block, fitted over a ratchet in the porcelain corresponding in breaks to the breaks on the porcelain ratchet of the switch barrel. The central part of the stem is flattened to take the rectangular section of the interior of the switch barrel and drive it.

The switch barrel is a porcelain cylinder, part of whose boring is rectangular; the cylinder surface is molded to form four ratchet teeth, two of which, diametrically opposite, are surfaced with copper sheet held by solder, the other two teeth are blank porcelain.

The line connectors are two long and two short, ending in binding straps. The long connectors are on a raised part of the

block and end in a vertical flange to which is riveted a snap finger bent round to bear on the curve of the ratchet teeth of the switch barrel. The short connectors are similarly fitted but are flanged down into a recess of the block to take the snap finger.

As the switch is snapped from a ratchet tooth, one long connector and one short connector on the same side of the block are either connected through the copper plates on the switch barrel or are insulated from each other on the blank teeth.

The polarity of the line is not crossed in the switch.

5-Ampere Switch, Single-pole.—This snap switch is the one generally inserted in lines branched to outlets for controlling the individual outlet, provided no greater current than 5 amperes is

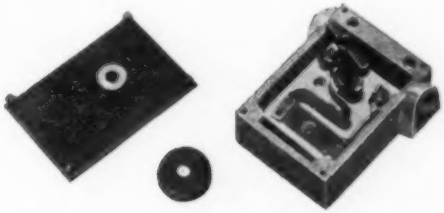

FIG. 47.—5-ampere switch, conduit.

to flow. The conduit type is shown in Fig. 47. (When the switch is to be at the end of a pipe, the type of box shell is similar to that shown in Fig. 49.)

There are but two screw wells located at the end which is fitted for the two bosses. The cover is held by four screws. The switch handle remains permanently with each box, and, to prevent water from entering, a rubber gasket and stuffing box are fitted to the cover, and assembled together by a standard cap, drilled to take the switch stem.

The switch being single-pole, the connectors are connected together by a copper plate. The connectors are of brass; one leads to the copper plate and thence towards the switch barrel, where a spring finger similar to one of the fingers for the 25-ampere switch, is secured by a screw; the other connector is short and secures a similar finger.

The switch barrel, is of porcelain, similar to but shorter than that for the 25-ampere switch. Over the barrel is slipped a

copper stamping which fits two diametrically opposite teeth of the barrel ratchet, to make and break connection with the connector fingers. The brass switch stem has rollers and ratchets beneath the block identical with those of the 25-ampere switch.

The switch barrel is held down by a steel spring which shoulders against a brass sleeve on the stem above the spring. Above the sleeve is a pin by which the thumb nut drives. The thumb nut is a casting having a small ratchet at its bottom face, and a spring in the core which takes against the head of the screw securing the thumb nut to the stem. This arrangement prevents turning the switch in the wrong direction and thereby bending the fingers; the thumb nut will spring up and back if the ratchet is turned left-handedly, and only the handle will turn.

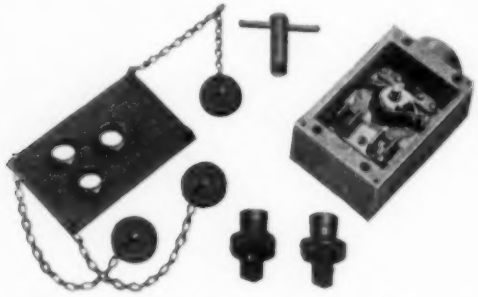

FIG. 48.—25-ampere switch and receptacle, conduit.

Receptacles.

The type is designed for the purpose of providing an outlet into which the wiring of movable fixtures can be plugged, for current supply, by means of one of the standard attachment plugs.

25-Ampere, Switch and Receptacle, Double-pole.—The conduit type is shown in Fig. 48.

The box has four screw wells, and with one boss at the end.

The cover is pierced for three entrances, two near the ends for the two *25-ampere attachment plugs*, and one near the center for the switch handle.

The block is the same as that for the 25-ampere switch. The difference for the remainder of the interior fitting and that of the 25-ampere switch is that the long connectors have a contact clip for the attachment plug instead of a binding strap. This contact clip is of phosphor bronze; the sides are bent slightly

out of rectangle and their upper ends are turned in to give a spring action in holding the plug.

5-Ampere Switch and Receptacle.—The conduit type is shown in Fig. 49.

The box is the same as for the 5-ampere switch excepting that the cover has an additional aperture for inserting the *5-ampere attachment plug*. (See description of 25-ampere attachment plug

FIG. 49.—5-ampere switch and receptacle, conduit.

and 5-ampere attachment plug for the important electrical difference in construction. This difference has been sometimes overlooked in fitting double conductor, plain, for fixtures.)

The block and switch are the same as for the 5-ampere switch; the difference for the remainder of the interior fitting and that of the 25-ampere switch is that the long connectors are not con-

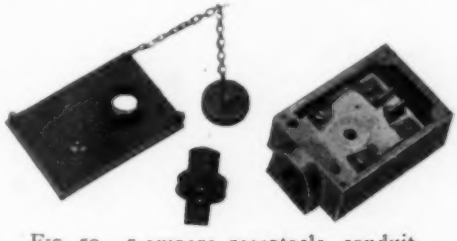

FIG. 50.—5-ampere receptacle, conduit.

nected together by a copper plate but end in one vertical phosphor bronze piece like one of the 25-ampere switch-and-receptacle contact clips. The 5-ampere attachment plug requires a gap and not a connection between the clips.

5-Ampere Receptacle.—The receptacle is for use where the switch combination is not required. The conduit type is shown in Fig. 50. The box is the same as for that for the 5-ampere

switch and receptacle except that the box cover has but one aperture, which is fitted with a cap. The switch parts of the 5-ampere switch and receptacle are omitted in the interior fitting; the straight brass connectors are connected through the box to the same type of contact clips as in the 5-ampere switch and receptacle; the other ends of the long connectors end in a contact screw.

The 5-Ampere Double Receptacle.—The conduit type is shown in Fig. 51, and is, in effect, two 5-ampere receptacles combined. The difference between this receptacle and the 5-ampere receptacle is that there is a set of clips at each end of the interior fitting instead of at one end only, and the box cover is cut with two apertures, for the insertion of two 5-ampere attachment plugs, each aperture being provided with a standard cap.

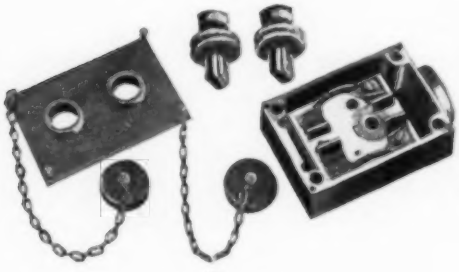

FIG. 51.

FIG. 52.

FIG. 51.—5-ampere double receptacle, conduit.
FIG. 52.—5-ampere switch, with hood, conduit.

The double receptacle is installed in staterooms for the two outlets required for one fan and one desk light, and takes the place of non-watertight receptacles, key and keyless.

5-Ampere Switch, Single-pole, with Hood.

25-Ampere Double-pole Switch and Receptacle, with Hood.

5-Ampere Switch and Receptacle, with Hood.

The distinction between these three types and the types which have been previously explained (without the hood) is merely in the shape of the box shell, of which a type is shown in Fig. 52.

The top of this box is curved into a semi-circle and is flanged out over the top to cover the face of the appliance and protect

the handle from loose gear about decks, or when the appliance is likely to be stepped on about hatches, or from the weather on uncovered decks. The box cover is cut to fit the extended and rounded shape of the top of the box shell, otherwise it is similar to those for the unhooded appliances.

Box Types for Interior Communication Circuits.

Connection Boxes.—Connection boxes are of four sizes, known as 20-wire, 40-wire, 60-wire, and 70-wire boxes. They afford a convenient means of branching out the interior communication leads, from the cable or from main wire leads, to the different locations in which a part of the wires are to be distributed or

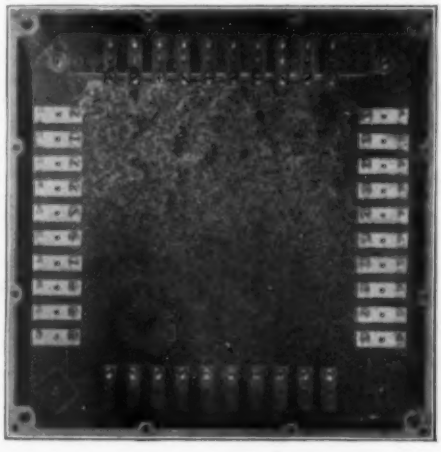

FIG. 53.—Connection box, interior communication.

are to connect to interior communication apparatus, as bells, annunciators, etc. The box and fittings are shown in Fig. 53.

The box is of cast bronze composition and is secured in place through four screw wells. In the bottom are cast four long bosses, on which rest the interior fitting carrying the terminals.

The cover is plain and is watertighted by a cloth insertion sheet-rubber packing, which only covers a portion of the inside edge of the box, the packing being secured to the cover by tap screws and by the screws which hold the cover to the box shell. There are no pipe bosses on the outside of the box, but on the

inside of each box wall are bosses which are to be tapped to take the ends of the conduit.

The interior fitting is built up of micanite into an open square and drilled at the corners to be secured by screws to the bosses; the corners are cut away to fit inside of the screw well masses. On the four sides of the micanite are secured the plates to which the wire terminals are held by screws; the terminals are copper stampings bent into tubular shape at the ends that the wire end may be conveniently entered and soldered.

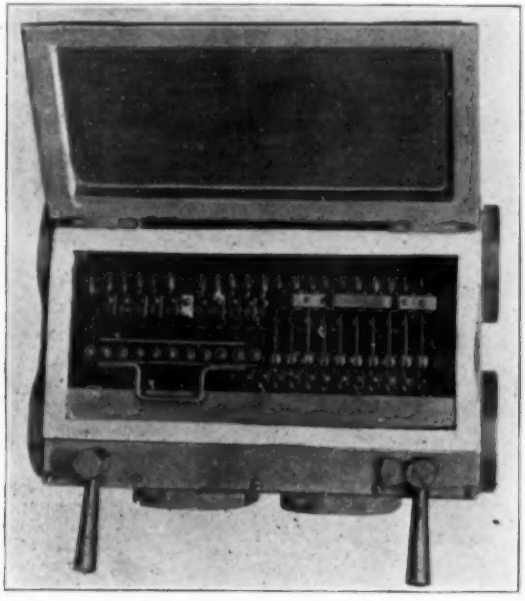

FIG. 54.—Action cut-out switch.

There are five plates on each side of the twenty-wire box, ten on each side of the forty-wire box, and fifteen on each side of the sixty-wire box, but the total number of connections can be increased by securing other terminals under the same screws, as in the case of several common returns. Necessary room is afforded in the bottom of the box for disposing of the slack of the conductors and the terminals are made sufficiently long to be bent down for convenience and as required. The number of the particular wire lead is stamped into the terminal by a die.

In the forty-wire box there are three bosses inside of each box wall, admitting of twelve conduits or box tubes, if required.

Cut-out Switch.—This switch (known as the Action Cut-out), is shown in Fig. 54; the size shown in the figure is for 22 wires. It combines in one appliance the means of cutting off a number of lines of interior communication which are to be used in action (and behind armor or other protection) from other parts of the same lines which are not required in action, and which latter from exposure to injury might occasion grounds or short circuits in the system.

The various uses of the switch are referred to under Installation.

The box is a composition casting. Bosses for the attachment of the stuffing tubes or conduits are located externally on the sides, to be tapped as required. Bosses are also cast internally on the sides, to be drilled to take the screws for securing the box in position when conduit is not installed.

Bosses are raised on the inner bottom and drilled and tapped to take the screws for holding the base.

The upper edges are tapped to take the cover screws, the corners being filleted and the bosses swelled out where the screws come between the corners.

The cover is of thick sheet brass with a central rectangular hole for ready access to the fitting.

Two lugs on the left hand edge form parts of hinges. On the right-hand side two inclined surfaces, called wedges, are cast which form part of the ready locking device for the cap. A cloth insertion sheet-rubber packing is inserted between the surface of the cap and the cover to watertight the appliance.

The cap is clamped by two handles which force the cap against the packing by pressure on the wedges in the same way as the dogs on a watertight door. The heavy extension of the handle prevents any loosening by jar.

On the inner surface of the bottom of the box is placed a micanite sheet to insulate the fitting and its screws from contact with the metal.

The interior fitting consists of a rectangular slate base on which are mounted a number of knife blade switches, single-throw, the blades being connected in sections to two or more common switch yokes. To each of these yokes is fastened an

FIG. 55.—Pulling sleeve.

open switch handle which admits of the simultaneous opening or closing of all of its contacts, the cap being opened for the purpose.

Terminals, to which the conductors are soldered, are fitted to each switch terminal, space being allowed for stamping the individual wire numbers.

Allowance of space is made between either side of the switches and the sides of the box for the leading in of the wires.

Transfer Switch (Interior Communication).—This switch is ordinarily of similar construction to the cut-out switch. The main difference is that the switches are double-throw to permit alternative locations, such as a chart house and conning tower, to be connected to the same lines. Its convenience resides in reducing the number of cut-out switches which would be otherwise necessitated and preventing two being on at one time.

The Watertight Box and Pulling Sleeve.

These two appliances have no interior fitting and are not strictly boxes.

Watertight Box.—This box is installed on conduit lines near a deck or bulkhead to stop the flow of water which may have entered the conduit from any cause, such as covers or caps being left off of boxes, or from rupture of the conduit in action in a compartment which has been flooded, or from condensation.

There are two similar types shown in Fig. 69, one of which is employed when the appliance can be located close to the bulkhead. The second type is for use when the appliance must be located farther away from the bulkhead from interference of structure or apparatus; it is similar to the former type, differing in the length of stuffing tube to be employed.

The box is merely a casting, bottom hemi-cylindrical, with

cover for access. Within the box one end of the conduit is watertighted by gland and gasket in the usual way; the box surrounds the end and preserves a continuity of the conduit, and the removal of the cover permits access to the gland and gasket for setting up. The gasket set up, the conduit is protected from communication of water between compartments.

Pulling Sleeve.—This appliance is shown in section in Fig. 55. It satisfactorily replaces, and is much lighter than, the former pulling box, and also obviates cutting a long length of wire.

Over the conduit shown is placed a brass tube whose ends are threaded outside, and are beaded inside, to take a rubber gasket, which is set up by a gland against a brass washer. The sleeve is a convenient device for access to the wiring, the ends of the conduit being separated a good distance as shown; the pressure of

FIG. 56.—Terminal box for staterooms.

the gasket retains the sleeve in place; when drawing wire the gland is slacked and the sleeve slipped along the conduit out of the way.

The different particulars for different size sleeves are tabulated as follows:

For Conduit I. P. S.	Outside Diameter.	Inside Diameter.	L.	S.	D.	Gasket.	Weight Complete.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.		lbs.
½	1¼	⅞	15	9	½	B-27	3.125
¾	1½	1 3/16	20	14	¾	A-34	4.375
1	1¾	1⅜	24	18	¾	F-42	7.500
1¼	2¼	1⅞	30	22	1	G-54	12.125
1½	2½	2	36	26	1⅛	J-61	21.250
2	3¼	2¾	40	30	1⅜	L-76	32.000

Terminal Box.

There are several sizes of this appliance which are used merely as a terminal base into which the wiring can be led and to which

some forms of appliance can be secured. In general they are similar to Fig. 56, but when several are to be assembled at the same place the box is made to include all in the same casting.

The type shown is that which has been used in staterooms for mounting push buttons for the bell circuits, and the switch for the lighting circuit. The conduits enter in an upper surface not shown in the figure.

Non-watertight Appliances.

Appliances of the non-watertight types are of commercial varieties, and replace the more expensive watertight types in locations outside of the watertight system of the ship, especially in those locations which are occupied as quarters, offices, etc. Non-watertight appliances should never be used in locations which will be washed down with hose.

FIG. 57.—5-ampere switch, N. W. T.

FIG. 58.—N. W. T. key receptacle.

5-Ampere Switch.—The switch is the single-pole, snap switch shown in Fig. 57.

The circular porcelain base has two raised bosses to which are held small brass connectors by screws through the base; the connectors are fitted with contact screws to which the leading wires can be directly connected, or they can be led through holes in the base. The copper fingers are riveted to the connectors and make contact on a switch barrel similar to the method of the 5-ampere watertight switch. The barrel contacts are held by a solder joint, run into a recess in two opposite ratchet teeth, and are connected together through the barrel. The switch stem is flared under the base and held by a slotted brass washer; it is secured to the barrel by a coiled spring, one end of which goes over a pin on the stem and the other takes in the interior recess of the barrel. The switch handle screws on and is held by a set screw.

The cover is of spun brass, lined with asbestos, dome-shaped, and finished in bronze; it is held in place by the switch handle and is kept from turning by a notch on the lower edge which fits over a lug in the porcelain base.

The switch is commercially rated at 10 amperes.

The direction of turning is to the right and no device except the resistance of the switch fingers prevents turning in the wrong direction.

The appliance is secured through screw holes in the base; when installed in connection with conduit work it is attached to a terminal box similar to that shown in Fig. 56 and the wires are led through the two holes in the base.

10-Ampere Switch.—The essential feature is that the switch is double-pole; this is important and has been much overlooked, causing errors in installation and contract deliveries. The base is the same as for the 5-ampere, except that the bosses are higher and there are four holes for the wires instead of two. Similar short connectors are used with the same construction of finger; four fingers are used, two in each pole, one of each pair being secured to the upper surface of the base and one to the boss. The barrel is similar to that of the 25-ampere watertight switch, the contact plates being secured by solder as in the non-watertight 5-ampere switch, and connected through the barrel. The stem construction, method of holding to the base, handle and cover fastening are the same as for the 5-ampere non-watertight, but the cover is higher to accommodate the extra height for the fingers and is lined with asbestos.

The switch turns to the right and has no device except the resistance of the switch fingers to prevent turning in the wrong direction.

The appliance is secured through two screw holes in the base; when installed in connection with conduit work it is attached to a terminal box similar to that shown in Fig. 56 and the wires are led through the four holes in the base.

Receptacles.

Key Receptacles.—The appliance is shown in Fig. 58.

The porcelain has a flat circular base with a central porcelain column. To the column is first screwed a D-shaped piece of brass in whose upright ends the key spindle journals. At the

key end this stamping is branched for a contact screw for one fuse; at the opposite end the journal is deepened to allow for the spring action. The key stem has a through pin or plate inside each side of the D-shaped piece to keep those sides in place, and on the opposite end from the handle and inside the D is a rectangular piece of brass which, when vertical, electrically connects the shell of the socket with the switch stem; the piece of brass works against a phosphor bronze spring plate to give a snap action.

The other electrical terminal is a tongue of brass ending in a plate against which the center of the lamp base, or attachment plug, rests, and to which the center connects electrically. The tongue is bent down and screwed to the column and is tapped in for the second fuse. The socket shell is cut away, where the tongue passes through, to give large room to prevent short circuit.

The socket shell is of spun brass, threaded to take the Edison base of the lamp or attachment plug; it is inwardly flanged at the bottom and held to the column by two screws.

The tongue is often bent down when a lamp or plug is screwed in hard and, to prevent short-circuiting, a disc of mica is laid under the tongue.

The wire contacts are two brass plates held by screws to the flat base. Each contact has two contact screws, one for the wire lead, the other for a piece of fuse wire to fuse the gap between the wire contact and the contact screw of the tongue in one pole, and that between the wire contact and the contact of the D-shaped journal of the switch stem in the other pole. The fuse is no longer used in naval work; the gap is bridged with a metal connector.

The cover is of spun brass with an aperture large enough to fit over the switch handle. A broad notch at the bottom, and directly below the handle aperture, fits over a corresponding elevation on the base and prevents the cover from turning. The cover is held in place by an insulating ring of hard rubber, whose internal thread fits the thread of the socket. The cover is lined with asbestos.

The receptacle is secured by two screws; when installed in connection with conduit it is attached to a terminal box, similar to that shown in Fig. 56, the difference being in the shape and arrangement of parts.

Keyless Receptacle.—This appliance, shown in Fig. 59, differs mainly from the key receptacle in the omission of the key construction; the column is not so high and has a one-sixteenth inch raised projection against which a broad tongue is held in the bend on the side by the fuse screw; the socket shell is held by two screws, and by a horseshoe-shaped connector which has a tongue and contact screw for the fuse in the other pole; the cover is lower and has no device to prevent turning. The wire contacts, fusing, and other details are similar to those of the key receptacle.

The keyless receptacle is installed when the local use ot a key is not necessary.

The double receptacle (Fig. 51) now replaces both the key and keyless receptacles.

FIG. 59.—N. W. T. keyless receptacle.

FIG. 60.—Standard key socket.

Lamp Sockets.

These appliances are the receptacles for securing and supplying the incandescent lamps in the various types of fixtures and instruments.

Key Socket (Fig. 60).—There are two parts, an interior fitting and a shell.

The function of the interior fitting corresponds in most details with the column parts of the N. W. T. key receptacle. It is not fused and there are no lower contacts as in the key receptacle; the key construction is the same in both. A commercial spun socket shell is secured to the porcelain by two screws and is cut off at the height of two threads, the remaining threads being replaced by a coiled spring of No. 11 phosphor bronze wire, of seven turns, of which three-quarters of a turn are soldered in the thread of the spun shell and 6¼ turns are free in the spring; the outer end of the spring is turned back in a

loop, *to be pressed back and loosen the spring when unscrewing the lamp.* The threads of the lamp base run in on the spring as on the thread of the socket shell of the key receptacle; the object of the spring device is to protect the lamp from loosening or breaking from the effect of shock or vibration.

The shell is in two parts, a top and a base. The top is of spun brass; it has one slot at the bottom to slip over the key stem, and two slots to slip over the retaining screws which hold it to the base by the pressure of the screw heads; the ends of these screws enter a recess in the porcelain and hold the interior fitting in place. The upper part of the base is of spun brass, reinforced inside by two spring straps, double the thickness of the brass spinning, to afford a bearing for the screws which assemble the side.

FIG. 61.—Standard keyless socket.

FIG. 62.—Type A socket.

The bottom of the base is a casting tapped for the pipe thread of the pipe of the fixture to which it is to be attached, a slotted head set screw preventing turning.

The wiring is led through the pipe and base to attach to the contact screws of the interior fitting. The shell is finished in dark bronze in consonance with the finish of the fixture with which the socket is to be assembled.

The side of the shell is insulated from the coiled spring by a ring of hard rubber, bent to shape and slipped in at the top between the shell and spring.

Keyless Socket.—The porcelain block for the interior fitting of the keyless socket (Fig. 61) differs from that of the key socket in the omission of key parts. The coiled spring and tongue connection are the same. As in the keyless receptacle, a horseshoe-shaped piece of brass is assembled with the inside flange of the bottom of the spun socket (to which the contact for one pole is attached). The side of the shell omits the slot

for the key, but is otherwise the same as for the key socket and assembled in the same way. The shell is finished in dark bronze.

Type A Socket, or Porcelain Base Receptacle.—This type of socket shown in Fig. 62, is now replacing the key and keyless sockets in many constructions (especially fixtures) as it is cheaper, has better insulation and is more readily wired up; the difficulty of leading in through the bottom of the base of the other two sockets, and attendant delay and cost is also eliminated. It has no cover or shell and consists essentially of the mountings of a keyless socket on a special porcelain base. The efficiency of circuit insulation in conduit installations is largely due to the use of this socket.

FIG. 63.—Candelabra base, or instrument lamp socket.

FIG. 64.—Push button, N. W. T.

The base is secured by a through No. 8 machine screw on one side, and on the other by a machine screw of the same size, which sets against a shoulder in a slot, permitting the taking up of a variation of one-quarter of an inch in centers.

A deep groove for the entering wires runs across the bottom of the base. The porcelain is so struck on the top of the base as to form a shoulder for leading the wires to contacts whose center line is 90 degrees from that of the bottom groove and in the same vertical plane as the securing screws. All screw holes for screws securing the mountings are countersunk and filled with a water-excluding material.

Instrument Lamp Socket.—This socket (Fig. 63) takes the 5-candle power instrument lamp base. The porcelain is held by screws at diagonally opposite corners.

The copper spinning and spring are constructed like the similar parts of larger sockets. One connector is soldered to the copper spinning; the other dips down into a recess of the porcelain, and extends up vertically into the socket center, where it is secured by a copper screw over an insulating disc of mica. The same screw acts as a wire contact and for securing the connector.

Push Buttons.

Push buttons are a simple variety of through-connection or switch for low-voltage lines, such as for bells and buzzers.

There are two types of push buttons: A flat type, known as Watertight and Non-watertight Push Buttons, to be installed against surfaces on lines of bell wiring; a pear-shaped type, known as Single, Double, and Triple Pear Push Buttons, designed to be attached to loose bell cords, to hang over tables, beside desks, etc.

Non-watertight Push Button.—The appliance, shown in Fig. 64, is a brass casting and consists of four parts, a base, a cover, an interior fitting, and a push.

The base casting is hollowed out in the center for lightness and for a direct lead for the wiring; it has a cast collar, threaded on the outside, to which the cover screws. In a recess of the collar is placed the interior fitting. The cover is a casting, threaded on its inner, lower edge to take on the threaded collar of the base, and perforated at the top for the push.

The interior fitting is a disc of hard rubber, perforated for two screws which hold the complete push button in place, and two smaller holes, through which the wires are led to the contact springs. There are two German silver contact springs; one, laid flat, and half-moon in shape to bring the inner end to the center of the hard rubber disc and at the same time clear the other connector, is secured to the disc by a screw, a second screw with small brass washer forming the wire contact; the second connector is bent into a spiral and is secured to the disc by a screw, the wire contact being the same as for the first connector, this connector is sprung off the disc to give a clearance of about ⅛ inch between its inner end and that of the first connector. The inner ends of each connector are fitted with a small pin rivet of platinum to decrease the effect of sparking, and insure a clean, bright contact.

A notch in the side of the hard rubber fits a lug in the base and secures the fitting against turning.

The push is a piece of hard rubber about 7/16 inch in diameter at the top, with a small flange at the bottom about ⅛ inch larger in diameter, which presses on the spiral connector inside the button, and brings the platinum points of the connectors

into contact. In conduit wiring the button is attached to a terminal box similar to Fig. 56.

Watertight Push Button.—The watertight push button is similar in construction to the non-watertight, but the base is made solid excepting for a perforation on one side about ½ inch in diameter, in which fits a hard rubber plug with two holes for the leading-in wires.

The construction of the interior fitting is similar to that for the non-watertight button. The cover is the same excepting, first, at the top is a collar with an outside thread, to which is fitted an inside-threaded ring holding in place a lace leather disc

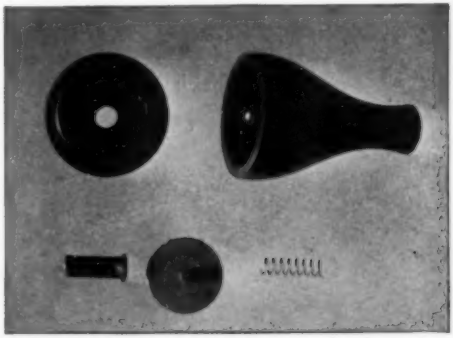

FIG. 65.—Parts of single pear push button.

which covers the push of the button and watertights the top; second, a watertight packing is placed under the cover. The lace leather is more serviceable than rubber, preserving its flexibility when exposed to salt water and not softening when acted upon by oil. In conduit wiring the button is attached to a terminal box similar to Fig. 56.

Single Pear Push Button.—The single type is installed when but one station is to be called. Fig. 65 shows the type of appliance. It consists of hard rubber turned in two sections, a base, and a cover; the cover is threaded to take an inside thread in the recess of the base.

The lower part of the base is drilled to take a double bell cord, and holes are drilled through to the base recess through which the bell cord can be drawn (after stripping the silk braid) and the wires branched out to the two contact screws, with washers,

within. In the center of the recess is bored a hole about ¼ inch deep, in which is set a spring which embraces the pin of the contact disc.

The contact disc is made of German silver, and has a small central pin to take the spring. This contact disc when pushed down on the two contact screws to which the wires are fastened completes the circuit between the two wires of the bell cord. A nickeled brass push is inserted through the hole in the cover to take on the contact plate; the push is kept in place by the cover; the contact disc is kept off the contact screws by the spring.

Double Pear Push Button.—This type is installed when two stations are to be called from one appliance.

The double pear push button is similar in appearance to the single pear push though slightly larger and has two pushes, one at the end and one on the side. The base is bored out leaving a wall thickness of about ¼ inch which is inside-threaded at the top to take the thread of the cover. Inside the base fits a hard rubber plug carrying the contact screws. The plug is planed off on one side for the connections for the side push, and holes are drilled through for the wires (without silk braid) of the triple bell cord. The battery wire contact screws for the top and side push are connected together by a brass strip.

The two contact discs, springs, and pushes are the same as for the single pear.

Triple Pear Push Buttons.—This type admits of calling three stations from one appliance.

The triple pear push is of the same size as the double pear and has two side pushes in addition to the end push.

The only essential difference is in the plug which is planed away on two sides for two side constructions similar to the side construction of the double pear push button.

The three-battery wire-contact screws are connected together by a strip of brass.

There being no standard bell cord, quadruple, the conductor is laid up by hand from single silk conductors.

Ceiling Button.—This is a small circular porcelain appliance used as a finish at the upper ends of bell cords, and is secured by two screws. The base of the ceiling button is hollowed out, and scored on opposite sides, for the lead of the bell wires, which are to be connected to the bell cord. In conduit wiring it is replaced

by a hard rubber bush in the cover of a terminal box similar to that used for the non-watertight push button.

Auxiliary Wiring Appliances

Gaskets—The term gasket is generally restricted in electrical installations to the eight types of soft rubber appliances for watertighting, of the shape of two truncated cones of unequal heights joined base to base, and resembling rubber corks; these are perforated to fit over the wires or conduits, and are set up by a gland and washer. Gaskets are generally molded from a rubber composition which is required to be as follows:

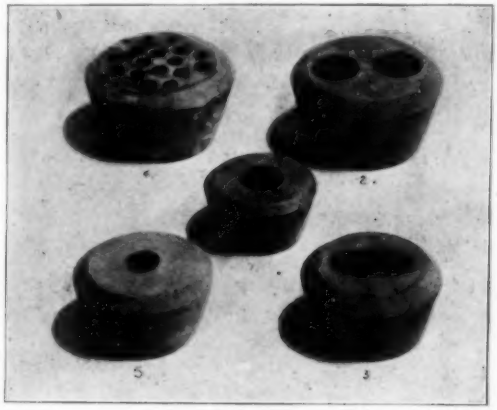

FIG 66.—Types of gaskets.

To be made of a vulcanized rubber compound which shall contain nothing but pure Para rubber gum, of the best grade, mixed with dry mineral matter and sulphur only. The compound to contain at least 60 per cent, by weight, of rubber gum, and the weight of sulphur not to be less than 4½ per cent nor more than 5½ per cent of the weight of the rubber gum in the compound This sulphur shall all be combined with the rubber so that there shall not be more than two-tenths of one per cent of free sulphur in the compound.

After vulcanization and manufacture into gaskets, the character of the compound to be such that when a test piece having a section of about 0.03 square inch is placed in jaws 2 inches apart, or as nearly 2 inches as may be practicable, and the jaws sepa-

rated at the rate of 3 inches per minute, subjecting the rubber to a tensile test, to be capable of being stretched to five times its original length, without rupture and not break under a tensile stress of less than 750 pounds per square inch.

When subjected to a tensile stress of 600 pounds per square inch continuously for ten minutes the compound to be of such a character as to return to within 15 per cent of its original length at the end of ten minutes after being released.

The specific gravity of the compound not to be less than 1.3.

The several types of gaskets are designated by a type letter in accordance with the outside dimensions of the gasket (Fig. 66). Varieties of the same type are designated by a number, generally separated from the title letter by a dash, which conveniently designates the diameter of the perforation in the gasket in thirty-seconds of an inch; for instance, A-14, B-20, D-13, indicate a gasket of A, B, or D, sizes in which the diameter of the hole is 14, 20, and 13 thirty-seconds of an inch, respectively.

If the type letter is a single letter, as A-14, it indicates that there is but one perforation in the gasket; if there are two perforations for the same size the gasket is called AA-14, etc.

When a gasket is represented as A-0, B-0, etc., it indicates that the gasket has no perforation and is solid; such a gasket is used for plugging up or blanking off, but the occasion is rare except with appliances for molding.

Gaskets which are designated by two numbers, as A-24-13, are for packing twin conductor, and have a single perforation with semicircular ends of which the first number, 24 in the example above, is the length of the perforation and is one thirty-second of an inch larger than the major axis of the twin wire; the second number, 13 in the example above, is the width of the perforation and is one thirty-second of an inch smaller than the minor axis of the twin wire.

Attachment Plugs.

Attachment plugs are appliances which are used on the ends of wire for plugging into receptacles, switch and receptacles and the like, and form the electrical connections to the permanent ship wiring of the particular fixture or apparatus to which they are wired.

5-Ampere Watertight Attachment Plugs.—This appliance, shown in Figs. 50 and 51, consists, first, of a hard rubber plug having a threaded collar at the top by which it secures in the assembly. On the sides of the plug are two copper connecting plates held by two brass screws, each having a contact screw under which one of the wires (usually from a double conductor, plain) are secured. The plates are insulated from each other by the substance of the plug, *and the plug is therefore double pole when inserted in the clips of the receptacle.*

The brass parts consist of a collar turning in a ring which is inside-threaded to take the tube of the box appliance, the recess being packed with a ring washer of sheet rubber packing to prevent access of water. The collar is knurled on the outside. The upper part of the brass tubing, into which the hard rubber plug is screwed, is reamed for packing with a D-13 gasket, and the gasket is held in place by a gland, working against a brass washer. The two wires of the double conductor, plain, are bared to the vulcanized rubber layer, and led down through holes in the hard rubber plug to connect to the contact screws.

This appliance has the great disadvantage that the screw collar at the top of the hard rubber plug has insufficient strength and is easily broken. A newer type of this appliance uses lignum vitæ boiled in paraffin instead of hard rubber. This type of plug is watertighted better at the leading-in wires than the type explained above; the breakage proves to be lessened only to a small degree.

25-Ampere Watertight Attachment Plug.—This type is to be inserted into a receptacle *which is single pole instead of double pole, the clips of the 25-ampere receptacle, or switch and receptacle, being connected across by the plug contacts from one to the other. The plug differs from the 5-ampere plug in having the contact plates connected across the plug end,* thus making it a single pole; the two leading-in wires attach to the contacts of either side.

Non-Watertight Attachment Plug.—This plug is shown in Fig. 67. It consists of a piece of hard rubber, recessed at the top for a depth of half an inch, and having a central hole dropping from the recess for a distance of ¼ inch. A screw enters this smaller recess from the bottom and secures a brass connector which is bent up into the larger recess and ends in a con-

tact screw for one wire, the screw completing the connection. On the outside of the plug is threaded a brass spinning which is connected through by a soldered wire to a contact on the inside. From this contact a fuse wire connects to a similar contact, placed at a distance of about ½ inch on the inside circumference of the recess, to which the second wire for the connection is secured. The commercial attachment plug is therefore fused; this is not necessary, one contact is now omitted, for naval use, and the fuse gap bridged.

The upper part of the plug is threaded on the outside for a brass cap, finished in bronze, which holds a hard rubber disc, covering the inside recess of the plug. The hard rubber disc and the cap are perforated to admit the conductors.

The appliance is used on the ends of wiring (usually double conductor, silk) for fans, desk lights, etc., but is now being replaced by the 5-ampere watertight plug by reason of the installation of double receptacles instead of non-watertight appliances.

FIG. 67.—N. W. T. attachment plug.

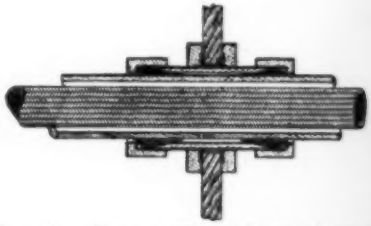

FIG. 68.—Cross-section of conduit tube through a bulkhead.

Stuffing Tubes.

The requirements of watertighting the fitting of various parts of conduit lines has given rise to a line of stuffing tubes differing for the particulars for which they are applied.

Conduit Tube.—The tube, shown in section in Fig. 68, is employed for watertighting *conduit* when run through decks or bulkheads. It is of drawn tubing and beveled inside the ends for the gasket; it is threaded for its whole outside length if the tube is to be short, otherwise an unthreaded portion is left in the central part of the tube and the ends are threaded for the necessary length for nut and gland; the length of the tube will differ with the thickness of the metal and wood through which it is to

CONDUIT STUFFING TUBES.

Nominal size.	Clearance hole in bulkhead.	Tube.				Gland.				Washer.				Nut.			Gasket.
		Seamless brass tubing, threaded entire length, 18 threads per inch.				Outside diameter.	Length.	Inside diameter at flange.	Thickness of flange.	Outside diameter.	Inside diameter.	Thickness.	B. & S. G. of tubing.	Over corners.	Over flats.	Thickness.	Type.
		Outside diameter.	Inside diameter.	B. & S. G.	Length.												
					For ½-inch bulkhead.	For 3-inch deck.											
½	1 1/16	1¼	¾	No. 5	2¼	.....	1½	⅝	1	1½	⅝	⅛	No 8	2 1/16	1¾	⅜	B. 27
¾	1 3/16	1½	1 3/16	No. 6	2¾	5¼	1¾	1 1/16	1	1⅝	1 1/16	⅛	.....	2⅜	2⅛	⅜	A. 34
1	1 13/16	1¾	1⅝	No. 5	2¾	5½	2⅛	1⅝	1	1⅝	1⅛	⅛	No. 8	3 1/16	2¼	⅜	F. 43
1¼	2 3/16	2¼	1⅜	No. 5	3½	6	2⅜	1⅜	1	2⅛	1⅜	⅛	No. 8	3⅜	3⅛	⅜	G. 54
1½	2 9/16	2⅛	2	.....	4	6½	2⅝	2	1 1/16	2⅝	2	⅛	.....	4 3/16	3¾	7/16	J. 61

be run. On the thread run two hexagonal nuts which clamp the tube to the bulkhead or deck. The recess in the nuts is packed with lamp wick and red lead to prevent a flow of water between the nuts and the metal to which the tube is secured. The gaskets are set up by glands running on the outside threads.

When conduit is run through armor a tube is not necessary, other methods of water-tighting being used.

Bulkhead Tube.—The bulkhead tube is a conduit tube *having but one end fitted for gland, washer, and gasket.* The jam nuts have a score instead of a recess which is to be filled with red lead to watertight between the nut and the ship metal.

The bulkhead tube accomplishes the ordinary demands of installation, the conduit tube being for locations where the conduit must be packed on both sides; it is better to use the recessed nut of the conduit tube than the scored nut of the bulkhead tube as lamp wick and red lead make a better joint than red lead alone.

If the bulkhead tube is to be short it is outside-threaded for its whole length, otherwise an unthreaded section is left in the center. It will answer for a deck tube as well.

Box Tube.—The box tube is a small, short bulkhead tube having no jam nuts, and, is used for stuffing wires entering fixtures, and similar uses which require a short tube only.

Watertight Box Tubes.—The modifications of the conduit and bulkhead tubes for this use are illustrated in Fig. 69, showing the arrangement when the watertight box can be located near the bulkhead—the more advisable—and also when such arrangement is not practicable.

Terminal Tube.—The terminal tube is worked on the end of a conduit line when necessary to watertight wiring which is to be run open to cleats, insulators, etc.

When the conduit is to end at a bulkhead the watertight box tube is used as a terminal tube, but modified as follows: The shank of the tube (the part threaded with a pipe thread) is threaded to the shoulder instead of only part way; this shank is made long enough to pass through the bulkhead, take a nut (with red-lead groove) on each side of the bulkhead, and take its half of the coupling joining it to the conduit. One of these nuts is set up tight against the shoulder of the tube; watertightness is secured by setting up on the nut on the other side of the bulkhead.

TUBE AS USED FOR BOTH BOX AND BULKHEAD
FOR USE WHEN BOX CAN BE LOCATED NEAR BULKHEAD
TUBE AS USED FOR WATER TIGHT BOX ONLY.
FOR USE WHEN BOX CANNOT BE LOCATED NEAR BULKHEAD.

FIG. 69.—Watertight box tubes and watertight boxes.

BULKHEAD STUFFING TUBES AND BOX TUBES.

Nominal size.	Clearance hole in bulkhead.	Tube.						Gland.			Washer.			Nut.			Gasket.	
		Seamless brass tubing, threaded entire length, 18 threads per inch.			Hard-rubber lining, ¾ inch longer than tube.													
		Iron-pipe size.	Diameter of thread.	Inside diameter.	Length.		Outside Diameter.	Inside diameter.	Outside diameter.	Length.	Inside diameter at flange.	Thickness of flange.	Outside diameter.	Inside diameter.	Thickness.	B. & S. G. of tubing.	Over corners.	Over flats.	Thickness.	Type.	Maximum hole in 32ds of inch.
					Bulkhead.	Box.										No.					14
⅜	⅝	⅜	⅝	0.62	1¼	1½	⅝	⅝	1	⅝	⅝	⅛	1⅛	⅜	1/16	12	1⅜	1½	⅜	D.	14
½	⅞	¼	⅞	0.82	1¼	1½	⅞	⅞	1¼	⅝	⅝	⅛	1⅛	⅜	1/16	11	2 1/16	1¾	⅜	C.	20
⅝	1⅛	1	1⅛	1.04	2	1⅝	1⅛	1⅛	1½	⅝	1⅛	⅛	1⅜	½	1/16	8	2⅛	2	⅜	B.	26
¾	1⅜	1¼	1⅜	1.38	2⅜	1⅝	1⅜	1⅜	1⅝	⅝	1⅜	⅛	1⅝	½	1/16	8	2¾	2⅜	⅜	A	36
⅞	1⅝	1½	1⅝	1.61	2⅝	1⅞	1⅝	1⅝	2⅛	⅝	1⅝	⅛	1⅞	½	1/16	8	3 1/16	2⅝	⅜	F.	42

TUBES FOR WATERTIGHT BOXES AND CONDUIT TERMINAL TUBES.

Nominal size.	Clearance hole in bulkhead.	Dimensions of all tubing.				Tube for watertight box.			Terminal tube.	Gland.			Washer, $\frac{1}{8}$ inch thick.			Nut.			Gasket.	
		Gland end.		Conduit end.		Total length.		Length of gland end, 18 threads per inch.	Total length.	Length of gland end.	Outside diameter.	Length.	Inside diameter at flange. Flange $\frac{1}{16}$ inch thick.	Inside diameter.	Outside diameter.	B. & S. G. of tubing.	Over corners.	Over flats.	Thickness.	Type.	Maximum hole in $\frac{1}{32}$ds of inch.
		Outside diameter.	Inside diameter.	Outside diameter.	Inside diameter.	Box only.	Box and bulkhead.														
In.	*In.*	*In.*	*In.*	*In.*		*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*No.*					
½	1 1/16	1	0.60	0.84	.....	3	6	1 5/8	3	1 1/16	1 1/4	¾	¾	¾	1 3/32	11	1 3/4	1 3/8	¼	C.	20
¾	1 5/16	1 1/4	0.80	1.05	.....	3	6	1 5/8	3	1 1/16	1 1/2	⅞	⅞	1 1/8	1 3/8	11	2 1/16	1 3/4	¼	B.	26
1	1 7/16	1 1/2	1.04	1.31	.....	3 1/2	6 1/2	1 7/8	3 1/2	¾	1 3/4	1 1/16	1 3/8	1 1/16	1 3/8	11	2 5/16	2	1/16	A.	36
1 1/4	1 13/16	1 3/4	1.39	1.66	.....	3 1/2	6 1/2	1 7/8	3 1/2	⅞	2 3/8	1 1/4	1 3/8	1 5/8	1 7/8	8	2 3/4	2 3/4	5/16	F.	42
1½	2 1/16	2	1.60	1.90	.....	3 1/2	6 1/2	1 7/8	3 1/2	1	2 5/8	1 5/16	1 5/8	1 7/8	2 1/8	8	2 15/16	2 3/4	5/16	K.	50

The enlarged part of the tube may be shortened to a length equal to that of the gland, or made longer if more advantageous.

A recessed nut is preferable to one with read-lead groove.

When the conduit ends flying, as in a berthing space, a short bulkhead tube is used for packing the terminal, screwing into a coupling. In similar cases when it is not necessary to pack the terminal, the type of terminal known as the T. & B. Bush or outlet insulator is used; its advantage is that the smooth, rounded, exterior edges will not abrade or injure the naked wire like the sharper edge of conduit pipe, however carefully the conduit may be finished off. The type is of cast iron and is commercial.

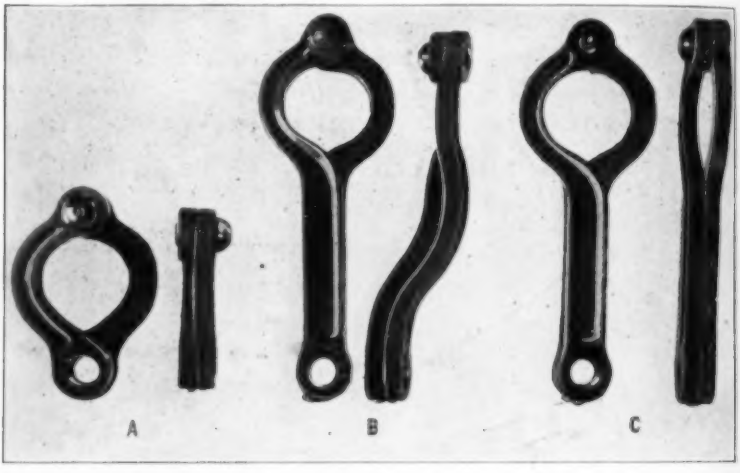

FIG. 70.—Hinged hangers.

Hard-rubber Bushes.—When wire or cable (without duct) is run through a bulkhead, etc., and watertightness is not necessary, such wire or cable is insulated at the bulkhead by bushes of hard rubber cut from hard-rubber tubing. To prevent the bushes from working out of place they are secured in as follows:

The tubing is cut about one inch longer than necessary for the aperture, and each end is softened in hot water. The bush is then put in place and a conical piece of metal placed in each end; the pieces of metal are connected by a through bolt and, as the nut is set up, the bush ends are flared, holding the bush securely in place when the ends have cooled and hardened. Straight bushes cut from tubing are used to bush all holes in beams, etc., through which wires are led in molding work.

Conduit Hangers.—Three types are shown in Fig. 70. *A* is the type for angle irons or against a surface having no offset; *B* is the type for double bulb beams, similar to *C* but having a curve in the shank to fit the bulb; *C* is a type adapted for channel beams or the flat side of a single bulb beam. The two pieces are of malleable iron and hinged below the swell for the conduit. After slipping over the conduit the drilled ends are brought to-

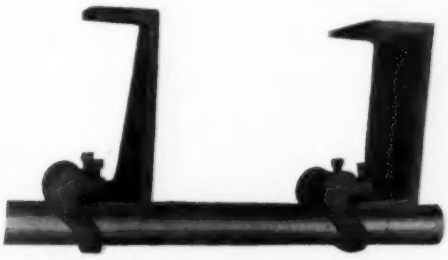

FIG. 71.—Hanger for channel beams.

gether and a ⅜-inch bolt put through both hanger ends and the beam or angle; a nut secures all in place.

The foregoing necessitates the objectionable practice of drilling the beam. Fig. 71 shows a type of clamp requiring no drilling or tapping of beams, but is adapted for channel beams only; it can be used for pipes of larger size than conduit. The clamp is

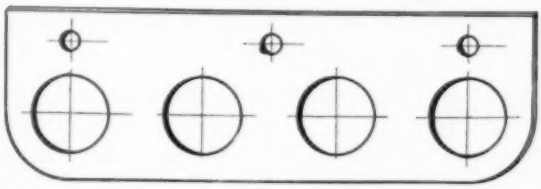

FIG. 72.—Plate metal hanger.

of malleable iron in one piece and draws the conduit securely against the beam by two case-hardened, square-headed set screws.

The type of hanger very generally used in contract-built ships is shown in sketch in Fig. 72.

It is of sheet iron or sheet steel, sometimes thin plate, which is punched or drilled to take conduit of the required size; it is secured by hexagonal-headed bolts through the beam and set up

with nuts. For bulb beams, etc., the plate is bent; an angle iron is attached for use against decks or bulkheads.

It has the advantage of being simple and comparatively cheap and of light weight; its disadvantages reside in having to take down a number of conduits when only one circuit is to be overhauled, and its inconvenience of installation near bends in the conduit. When this type of hanger is installed the number of conduits in any one hanger should be restricted to that which will insure a small amount of labor in handling the conduits for repair work.

Conduit Straps.—Conduit straps (Fig. 73), are for securing conduit when run along flat surfaces and are made of the same material as the conduit which they secure.

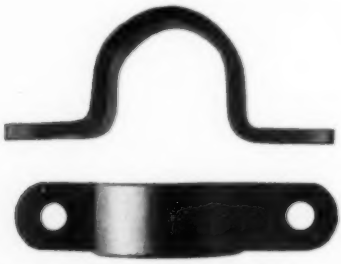

FIG. 73.—Conduit straps.

There are two types, a light, known as A and C, and a heavy, known as B and D. The light straps are made of No. 16 U. S. S. G. sheet iron, or No. 14 B. & S. G. sheet brass; they are used in quarters, etc., where the conduit is not likely to receive mechanical stresses. The heavy straps are used elsewhere and are made of 3/16-inch iron or brass.

The light types are secured with a 5/16-inch button-head cap screws, the heavy with 3/8-inch iron, hexagonal tap bolts.

Lock Nut.—Single lock nuts, as distinct from the jam nuts for stuffing tubes, are occasionally required for following up a coupling to its place on a joint. They are of cast iron and of commercial pattern.

Cleats.—Porcelain cleats (*A*, Fig. 74) are sometimes used in non-watertight wiring instead of insulators for securing wiring in place. They are of commercial porcelain types in a variety of sizes, and are secured by machine or wood screws as necessary. The cleat is usually reinforced by a metal cap or plate, to hold the pieces of porcelain temporarily in case of breakage or fracture.

Hooks.—Three types in general use are shown in Fig. 74.

B is a type derived from the post of the upper part of the desk light fixture and intended to be placed in convenient places

about staterooms, etc., for hanging the lamp carrier when taken off the base stand.

C is a type for suspending the bight of bell cords and the desk light wires; the hook part is covered by a rubber sleeve for insulation and to prevent chafe.

D is the ordinary commercial 1½-inch cup hook, for the same purpose as *C*, but for securing in wood only.

Fuses.

A fuse is an appliance which is inserted in an electrical circuit to protect that circuit from a current of such a magnitude as

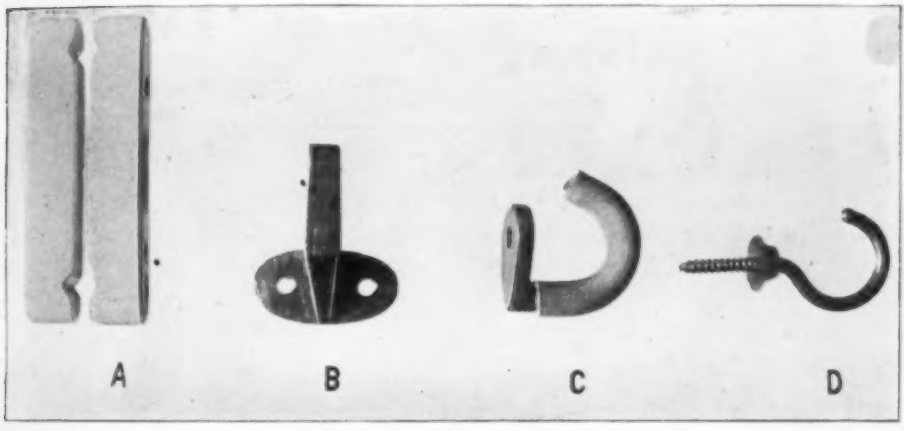

FIG. 74.—Cleats and hooks.

would overheat and injure the apparatus or the insulation of the wire; the fuse melts and breaks the circuit. Fuse material may be of any metal or alloy; the restricting conditions are, that the material shall melt under the heat generated in the conductor when the maximum permissible current passes, and that the fuse shall be sufficiently substantial to permit ordinary usage in handling, though not to be too bulky. Pure copper has certain advantages, but is not available, the principal objection being that the high temperature of the fused metal introduces a risk from fire.

The determination of fuse dimensions and material is based upon equating the amount of heat generated in the fuse, at the

temperature of fusion, with the heat radiated from the surface under the same conditions; the equation eliminates length of fuse and time, but in practice it is found that the length should be many times the diameter to compensate for the cooling effect of the clamps or terminals to which the fuse is attached. The practical determination of proportions for the alloy for fuses for naval use is determined by standards of temperatures of fusion, Fahrenheit, as follows: (Manufacturers differ in variations of mixture and proportion):

Melting Point.	Lead.	Tin.	Bismuth.
210°	5	3	8
246°	1	4	5
286°	..	1	1
334°	..	2	1
334°	2	3	..

The character of the alloy is specified to be such that there will be no reddening or excessive elongation when the current is slowly raised until the temperature of fusion is reached, and the maximum current is to be double that of the rated carrying capacity of the fuse, that is, a fuse rated at 20 amperes should not "blow" below 40 amperes. All fuses should carry 50 per cent of current above their rated capacity without being affected. The carrying capacity, or maximum permissible amperage, is determined by cross sectional area for a given alloy; when the cross section is circular the diameter is taken as the measure of cross-section.

Dynamo Fuse. (Fig. 75, A).—It is inserted to bridge the gap between the switchboard terminals for the dynamo leads and the terminals to which the bus bar connections are made; if a circuit breaker is installed at the switchboard end of the dynamo leads, a fuse is unnecessary, but if the circuit breaker is mounted on the dynamo headboard a fuse is properly inserted on each leg at the switchboard. Dynamo fuses are copper tipped and designed to mount on ⅜-inch bolts, with 2⅛-inch distance between centers; the copper tips are proportioned in thickness to the capacity of the fuse. The standard rated capacities are 25, 50, 75, 100, 200, 300, 400, and 500 amperes. The rated capacity is stamped on one of the lugs. Dynamo fuses made entirely of zinc have proved satisfactory.

Switchboard Circuit Fuses.—This type is employed to fuse the gap between the circuits on the switchboard and the bus bars.

The type for the former 1892 standard switchboard, and known as the push-clip fuse, is shown in Fig. 75, *B* and *C*, which differ from each other mainly in the thickness of the copper clip. The type used with the present standard switchboard is shown in Fig. 75, *D*. They are of the commercial copper-tipped pattern, designed to mount on No. 10 screw studs, with 1 11/16 inches between centers. The slots in the tips are at right angles. The material is either fuse wire or fuse strip. The rated capacity

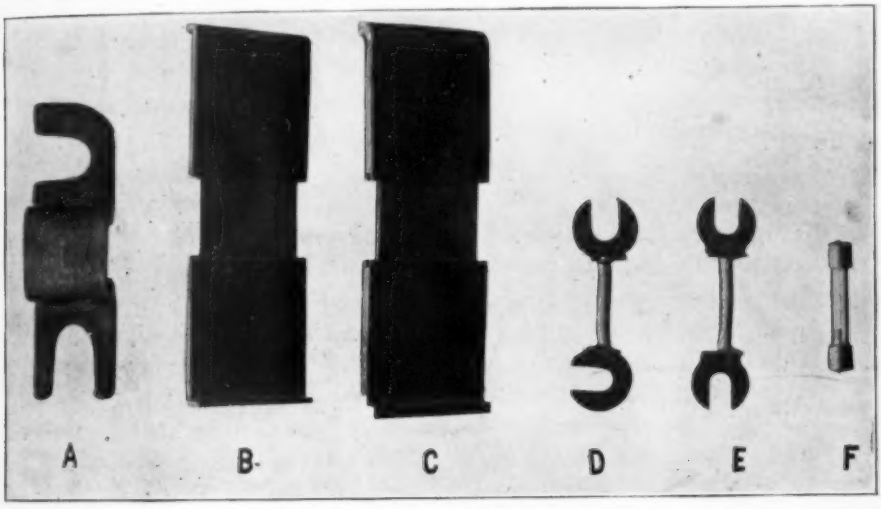

FIG. 75.—Types of fuses.

is stamped on one of the tips. The actual length of fuse metal must be at least one inch.

The different rated capacities of switchboard fuses are 10, 15, 20, 30, 40, 50, 60, 75, and 100 amperes; when a fuse of greater capacity than 100 amperes is required, as for a motor circuit, a dynamo fuse is employed.

Feeder Box Fuses.—Fuses for feeder boxes (Fig. 75, *E*) are of commercial copper-tipped pattern, designed to mount on No. 8 screws with 1 9/32 inches between centers. The tip slots are lengthwise of the fuse. The actual length of fuse metal must be at least an inch. The rated capacities are the same as for the switchboard circuit fuses, the sizes in common use being

10, 15, 20, 30, 40, and 50 amperes. When placed in the feeder box the length is accommodated by bending the fuse wire around the inside periphery of the mica cup.

Glass-tube Fuses.—The fuse for branch junction boxes and distribution boxes is shown in Fig. 75, *F*.

It consists of a piece of glass tubing 1⅛ inch long, over which a centrally perforated copper tip, ¼ inch long by ¼ inch diameter, is cemented at each end. A piece of 4-ampere fuse wire is threaded through the fuse, turned over at each end and soldered to the tip. The tips fit in the clips of the interior fitting for the junction box.

Sounding tubes which have been used in the Navigational Sounding Machine answer well for the glass tube section.

The fuses are rated at 4 amperes, for 80 volt circuits, and 3 amperes for 123-volt circuits.

Tape.

There are three varieties: pure Para rubber, vulcanized rubber, and cotton tape; each variety is supplied in three widths, ½ inch, ¾ inch, and 1 inch.

All tapes should be of the best commercial grades, of recent manufacture, the surfaces smooth, the body free from holes, the edges straight and without selvage, and the widths even.

Pure Para tape should always be used next the bare copper, when covering a break, splice, etc. It is to be approximately 1/64 inch thick, contain a minimum of 98 per cent of high grade pure Para rubber, and show a maximum of 2 per cent of ash when burned. The color to be brown and the layers separated by paper in the rolls; all rolls to be wrapped first in oil paper and then covered with tin foil.

Vulcanized rubber tape is not suitable for good insulation next a bare wire; it is used as a layer over, and extending beyond, the pure Para tape; being easily injured, it is not suitable for outside layers. It is to be approximately 1/40 inch thick, to contain from 45 to 55 per cent of high grade pure Para rubber, and show from 55 to 65 per cent of ash when burned. The color to be black and the layers separated by linen in the rolls; all rolls to be wrapped in oil paper.

Cotton tape is for use as an outside mechanical layer over pure Para tape, or vulcanized, or both. It is not suitable for the

innermost layer when insulation is required. It is to be approximately 1/50 inch thick, to develop between 40 and 45 per cent of ash when burned. The color to be black and both sides of the tape to be frictioned with a rubber compound. The layers of tape in the roll need not be separated, but the rolls must be first covered with tissue paper and then enclosed in tin foil.

Cotton tape and vulcanized tape are not ordinarily very adhesive, but are made so by warming up moderately after wrapping on.

Inspection of Wiring Appliances.

Ducts.—*Molding.*—Molding material follows the Navy Department specifications for the particular kind of lumber of which it is to be made.

The molding as made is gauged to the dimensions of the drawing, particularly as to gutters and side walls.

The capping design must contemplate securing to side walls and not to the wall between the gutters.

Pine molding must receive a priming coat of paint directly after manufacture.

Conduit.—Conduit is first calipered inside and out and the various lengths are measured. Each length is examined internally against a strong light to detect any fins and burs which would injure wire in drawing.

The ends are to be threaded externally for right-handed couplings; the inner edges must be slightly beveled.

The enamel coating must be of three coats inside and out; this is usually determined on the basis of the thickness and comparison with formerly accepted conduit.

The enamel of three pieces of the conduit is tested by acid; one of each with sulphuric, nitric and muriatic acid, each acid of 30 per cent strength, the duration of exposure to each acid action being 24 hours.

One piece is subjected for 24 hours to the action of a saturated solution of lye. Enamel which resists the action of the acids will frequently soften under the lye test.

A fourth piece of conduit is subjected to a temperature of 100° C. for two hours. The enamel must not soften or run.

A fifth piece is bent cold at a radius of fifteen times the iron pipe size; under this condition the enamel should adhere with smooth surface, and without cracks or knuckles.

Flexible conduit is so little used that it is practically obsolete; what is used is a cotton jacketed hose, whose inspection follows that for hose specifications, the important point being the inspection of the rubber lining.

The rubber compound is to contain 35 per cent fine Para rubber; the composition is tested chemically, and for tensile strength, elongation and permanent set exactly as prescribed for rubber layers of standard wire, and the prescriptions for test are identical with those for wire.

Box Types.—Box types are mainly to comply with standard drawings as to the various details.

Especial attention should be paid to the following:

Boxes and covers must be drilled to jig to guarantee interchangeability and fit of spares.

The box should be thoroughly painted inside with an air drying enamel. This, whilst not demanded by specifications, is important, as the box dimensions have been reduced to the lowest possible limits and the insulating coat is to guard against arcing from the current carrying parts.

The distance between centers of bottom bosses, for holding the interior fittings, must gauge as prescribed by drawing; otherwise the screw holes of new fittings will not register.

The bottom of the box must be well covered by a sheet of mica—micanite in some cases; this is to insulate the block of the interior fitting thoroughly from the bottom of the metal box when the porcelain has absorbed moisture.

Current carrying parts must not be nearer than ⅛ inch to any metal part of the box, including screws. This does not apply to special boxes and is to be regarded as the minimum; the nearness of live parts to the metal is now so small that, for boxes for conduit, not intended to be secured by screws, the screw well bosses, when inside the box, are usually milled off in practice. It is frequently done also with the lower parts of the ribs for the cover screws.

The micanite plate which separates the fuses in special feeder boxes must be secured at the base and not by tongues extending down the sides; the latter case vitiates the required distance for good insulation.

The cloth insertion sheet rubber packing which lines the cover must be so well cemented on as to insure against tearing off at

the edges or from any part of the surface when removing the cover; this is especially to be guarded against when merely edge packings are used.

Box types for interior communication circuits are to comply with drawings, and are inspected as explained for other boxes, as the case may apply.

Non-watertight Appliances.—These appliances except fuses, gaskets and tape, are inspected in comparison with standard sample, being of the general commercial forms.

Fuses.—The main items of consideration in testing fuses is that they shall readily sustain their rated current, shall not blow under a current value of twice the rated value, and shall not redden, nor show excessive elongation under any current value up to that represented by twice the rated carrying capacity for the particular fuse.

A special type of marble panel board is used for the test, on which are assembled: a pair of bus bars; an ammeter; a main line, double-pole, switch; and a "hatchet" switch.

The energy is supplied by three storage batteries at 6½ volts. The positive lead is connected to the main switch through one or more rheostats, having capacities of zero to 10 amperes, zero to 100 amperes, and zero to 400 amperes. Short-circuiting the rheostats gives a total capacity of 700 amperes; when fuses of greater capacity than 350 amperes are to be tested, the testing is done from the leads of the main switchboard at the test plate (for generating sets).

The ammeter is connected in the positive lead of the main circuit.

The bus bars have in parallel the following appliances for connecting the fuses in circuit: A non-watertight receptacle, for non-watertight attachment plugs; a 4-way branch junction box, for glass tube fuses; a feeder junction box, for corresponding type of fuse; two stud contacts, for switchboard clip fuses; and two stud contacts for dynamo circuit fuses.

The hatchet switch is a special construction having two oppositely placed knife switches, bent back from a right angle, giving the appearance and name, and having a set of clips to the right and left connected to the line; its use is explained in the following example:

Assume that a 200-ampere dynamo circuit fuse is that to be tested.

The fuse is inserted in the appropriate studs of the bus bar, the line is connected up through the 0-400 ampere rheostat and the hatchet switch is thrown to the right hand contact; in this position the current will pass through the line only and not through the fuse. The current is now adjusted by the rheostat until the ammeter shows 200 amperes. The hatchet switch is then thrown to the left, by which the main line current is transferred through the fuse, but by the construction of the switch *the current of the main line is flowing through the fuse before breaking the right-hand connection for the switch;* this necessary arrangement obviates any extra current through the fuse incident to breaking contacts in the ordinary way and the fuse will be subjected only to the actual current in circuit.

The hatchet switch is next thrown to the right (fuse cut out) and the main line current raised to 300 amperes; then the switch is thrown to the left, as before, and the fuse subjected to 300 amperes (150 per cent). In both cases the fuse should not be affected.

Without altering the position of the hatchet switch (fuse still in circuit) the current is slowly raised by the rheostat to 400 amperes (double the rated capacity); the fuse should not blow within from ten to thirty seconds after receiving the maximum.

If the fuse blows appreciably below ten seconds, it is rated too high; if for more than 30 seconds, it is rated too low.

No reddening or excessive elongation should appear at any stage of the test before blowing.

Molded Gaskets.—The specifications for molded gaskets have been cited in the description. Their test follows the same rubber test, chemically, for tensile strength, elongation and permanent set, as explained for rubber layers on wire, for compliance with the specified details. No other test than the gauging of the dimensions externally and of perforations is required.

In selecting a sample for test in the Riehle machine a strip, as long as possible, is cut from the circumference, the cross section being determined by caliper.

Tape.—The rubber constituents are determined chemically as for rubber layers on wire. The percentage of rubber in a weighed sample is obtained by burning the sample; the difference between the weight of sample and ash being accepted as the weight of rubber filling.

DISCUSSION

How to Have the Ship's Store We Want.

(See No. 119.)

Pay Inspector J. A. Mudd, U. S. Navy.—Most of us feel grateful to Paymaster Dyer for his timely and instructive paper on the "Ship's Store and Its Possibilities." It is time that this important matter was being handled in earnest. What interests me especially at the present moment, is the prize Mr. Dyer offers to all comers. He ends his paper with the following:

"Given concerted determination to find them and means will not be lacking to organize a ship's store system for the navy. When found the whole service will say, 'Hail! to him who will give it form.' This 'Hail!' from the whole service is worth working for."

A ship's store system supported with public funds, and therefore, subject to all pertaining governmental laws in its administration, would not be the thing. The statutes in regard to purchasing and accounting for public supplies were formed as much to give all citizens a fair show at the government's business as to protect it from thieves. The reasons for the existence of the ship's store are the convenience, comfort and enjoyment of the enlisted men; and it cannot be claimed it is practicable to allow every citizen to bid at any time for the privilege of contributing to the happiness of our good sailor men. Keeping the administration of the stores from the control of the laws governing the purchase and care of public property, while at the same time it is kept in the hands of officials whose integrity is not likely to be questioned, makes possible a *business-like* management, resulting in the men getting *exactly* what they want, at the lowest price.

Going to the other extreme; a ship's store worked with the private funds of persons outside the naval service would not do. What is called the "tenant" system in the English navy is probably of this description. The *entire* administration of the stores should be in the hands of persons whose only thought in the business is the welfare of the men, and not the size of their own bank account; practically, this means that naval officers should have control of the stores.

Admitting, then, that the capital of the ship's stores should not be contributed from the public funds, that the administration, in its entirety, should be in the hands of naval officers, and that the present practices are bad, what kind of system can be worked out so as to make the whole idea of a ship's canteen an established, lasting success?

The property of all the ship's stores, that are solvent, belongs to the

enlisted men. Most of the cost of running these stores has been, and is being paid by the government. If the property was turned over by the men to a board of trustees, all naval officers, to be kept by them and used for the benefit of the enlisted men of the naval service, as they, the trustees, might deem proper, a central control would at once be possible, and the rest would be plain sailing. This transfer of the direct property rights to the control of trustees could be accomplished by means of a vote of the crews of the ships having solvent stores. The proposition voted on could be something like this:

"That the entire funds and other property of the ship's store of the U. S. S. ——— be transferred, with all direct rights, to a board of trustees, consisting of the Chief of the Bureau of Navigation, the Paymaster General, and the Judge Advocate General, of the navy, to be kept by them in perpetuity, and used for the benefit of the enlisted men of the naval establishment; the Chief of the Bureau of Navigation to be the permanent chairman of the board and the Paymaster General its permanent treasurer and executive officer.

"*Provided,* that Congress, by resolution, agrees that the government bear all the expense of the administration of the ship's stores, and permits the keeping of the funds pertaining thereto in the U. S. Treasury, or other public depositories, subject to check of the trustees, or their duly authorized disbursing agents; and further, *Provided,* that should the position of any or all of the officials mentioned cease to exist by operation of law, the vacancy, or vacancies caused shall be filled by the President of the United States, by the appointment of the incumbents of positions corresponding as nearly as possible to those herein mentioned."

There need be no anxiety as to the result of the vote. Our men, in such important matters, see right from wrong as quick as a flash, and they would recognize, without the aid of spellbinders, that this move was very much for their good. The affairs of the stores, once in the control of three such trustees, would be as safe as man here on earth can make anything. The intelligence and experience of these gentlemen would enable them to devise a proper system for maintaining the stores; and, in a few years, no doubt, there would be sufficient funds for establishing a store on every ship in commission.

The articles carried would be uniform in style, quality and price. They would be bought in large quantities, *by any method the trustees chose,* and stowed at depots, say at New York, Mare Island, and Cavite, and served out to the ships as needed. *All supplies should then be purchased direct from the manufacturers.* He would be a silly manufacturer who would protect the middleman against the trustees, in the business of supplying forty thousand men, when he would run the risk of his article being replaced by some other. With this grand power for efficiency in their hands, I do not think we would ever have a trustee who would propose purchasing by means of advertisement and sealed proposals.

Then the baneful shadow of some of those who make a specialty of supplying our canteens would no longer be cast across the navy yard dock the minute a ship ties up, and the navy would be rid of these men,

who so often promote extravagance and encourage indebtedness; who, with their blandishments get their very existence sometimes out of that notorious gullibility that still seems to go with the sea-habit.

I still have lots of detail in my mind, but perhaps all I could now add would occur to most minds anyway. Do I hear in the distance that coveted shout of "All hail!" or is it only the sound of the scornful laugh of him who has found an unpatchable flaw in my ways and means?

The Ship's Store and Its Possibilities.

(SEE No. 119.)

Commander V. L. COTTMAN, U. S. Navy.—I have read with a great deal of care and interest "The Ship's Store and Its Possibilities," and congratulate the author on his excellent article.

It is well-timed, as, just at present, everything concerning the navy seems to be receiving consideration by the Department.

This is a subject that can well be included in the labors of the Personnel Board, as it affects directly the welfare of all officers as well as the enlisted force. The term "canteen" seems objectionable to the general public and it should pass out of our vocabulary, substituting store, ship's store, station store, yard store.

There should be on board every ship in commission, including station and receiving ships, and at every navy yard and station, a store, under the Bureau of Supplies and Accounts, where officers and men, and their families, can purchase all the necessaries and some of the luxuries. The supply depot should be at the store at the navy yard, New York.

The funds for creating and supporting these stores should be furnished by the Bureau of Supplies and Accounts out of the appropriation "Provisions, Navy," which appropriation should be increased at the coming session of Congress so as to allow four thousand dollars to vessels with largest complement, and one thousand dollars to vessels of smallest complement, and proportionate amounts to other vessels and to naval stations.

There should also be established at the clothing factory at the New York Yard, a branch for furnishing officers with outfits of clothing, including caps, and all officers should be required to purchase their uniforms there, then there would be uniformity in color, cut and style of uniforms, which is not now the case.

Officers could then fit out as they do now before starting on a cruise, and any articles needed whilst on a cruise should be forwarded by government conveyances at stated periods. This would produce, at less cost, better uniformed officers.

The Modern Mess.

(SEE No. 118.)

P. A. Paymaster A. HOVEY-KING, U. S. Navy.—Paymaster Dyer's extremely able article in the June issue of the Journal of the Naval Institute shows much careful thought in regard to the question of the adminis-

tration of the general mess aboard ship. His article, however, has been based upon the assumption of experienced and capable galley forces. It appears that while the galley forces are capable to a certain degree, the conditions surrounding the enlistment of ship's cooks and bakers, or their being given those ratings after entry into the service originally in the deck divisions or engineer's forces, are not as carefully considered as may be. I have known of cases where men being examined for the rating of ship's cook, fourth class, have been put through an oral examination. This is not given as a criticism, merely as a statement of facts. To ask a man whether or not he can bake bread is one form of examination—certainly not the best. It has worked in a number of cases satisfactorily. It is not, however, in accordance with the progress which is being shown by the naval service with regard to the enlisted personnel.

The present rates of pay for men in the commissary branch compare favorably with the wages paid to men of these trades in the big hotels and restaurants, so there is no reason why the naval service could not have as efficient men for its use. Only the best quality of provisions are obtained—of a quality certainly equal to those used in the average American family of moderate means. Provisions are made by the Department for the most modern equipment of the ship's galleys; the ration has been expanded to include every possible variation of healthful and pleasing food. Therefore the question of the personnel for its preparation is the only remaining one. The recommendations embodied herewith are, apparently, such as to amply cover the one unsolved point. That is, with the highest quality of food and the most modern equipment, only the most competent forces should be employed for its preparation.

In making the following suggestions for the improvement of the existing conditions and for the certain enlistment of capable men for the galley forces, I am merely quoting practices found to be a success both in civil life and in other branches of the service. If the care and consideration which are being shown to the improvement of the commissary conditions in the navy are not kept up with by a corresponding progress in the selection of men to perform the duties alloted to the galley forces, the effect of the valuable time and effort expended for the furtherance of commissary conditions is seriously hampered.

It is a well known military axiom that no officer charged with the supervision of enlisted men can thoroughly and competently handle men under him unless he himself is sufficiently familiar with the subjects common in his duty to inform them as to the correctness and incorrectness of their methods. The British Navy conducts a victualing course, so-called, at their naval dockyard, at Portsmouth, where pay officers of that service are taken under a course of instruction in the preparation and supervision of the cooking and serving of food for the service. While, of course, the ration provided for the British Navy is by no means as ample or as varied as it is in the American Navy, their food is always excellently cooked.

Our American Army, in their School of Application for Cavalry and Field Artillery, maintained at Fort Riley, Kansas, pursuant to an act of

Congress, approved January 29, 1887, maintains a Training School for Bakers and Cooks, which is under the supervision of the commissary officer of that post, and where officers of the Subsistence Department of the army are ordered for courses of instruction, covering a period of two months. While the course followed in their school for bakers could be adopted verbatim for the navy, certain alterations would necessarily be made in their course of instruction for cooks. I would suggest in this connection that a number of the younger pay officers of the navy be detailed to undergo a thorough course of instruction at the army school at Fort Riley. I have no doubt that the War Department would gladly grant the permission to attend to such officers of the navy as might be designated by the Navy Department. With this foundation, carefully prepared by the Commissary Department of the army through years of experience, pay officers of the navy would be basically well equipped for commissary work and, in the course of a few years would be available to undertake the instruction of their juniors in the corps in these very important duties.

The instructor of cooks at the army school mentioned is a retired soldier of long experience in the army, while the instructor of bakers is an experienced civilian employed by the War Department under special authority.

It would not be at all difficult to found a thoroughly efficient school for naval cooks and bakers at one of the large recruiting rendezvous, such as Newport, Norfolk, or New York. By establishment in the latter city, ample conditions would be available for practical work in connection with the receiving ship there, while it would not be at all difficult to obtain the services of experienced cooks and bakers from civil life to conduct special classes of instruction.

No hotel or restaurant of any importance in the United States exists where comparatively untried men are placed in positions of responsibility without long previous training. A baker, for example, must have served an apprenticeship of three years at his trade before he reaches the dignity of a journeyman baker and is eligible for employment in a big establishment. Even then he serves some years before he is advanced to the further dignity and comparative financial ease of a foreman baker. When they have reached this position in their trade they can command from twenty to twenty-five dollars a week. An experienced journeyman commands from ten to eighteen dollars a week, while an apprentice usually starts at four dollars, and at the end of his apprenticeship has reached ten dollars, if he is able. Such restrictions apply equally well to cooks.

While I do not doubt that every reasonable precaution is used by recruiting officers to secure only experienced men in these trades for service in the navy, results show that while a number of naval cooks can prepare, in a fairly effective manner, a number of dishes, any attempt to vary the ration by the preparation of less common dishes is apt to meet with failure.

In other words, unless a man enlisted in the navy as a baker or cook can show satisfactorily by references as to his prior employments, and can

further, on being sent to a training school for cooks and bakers, demonstrate his efficiency in the actual work of a galley, he should be discharged as unsuitable for the naval service, or should be given a four-month's course on lines which would thoroughly prepare him for his duties. If the army, from a three years' enlistment, can spare a man for four months, certainly the navy, with a year longer can do so. Men in the army who are considered worthy of the course are allowed to take it, on the recommendation of their commanding officers, even when there are only eighteen months remaining on their enlistment.

Under the present system men are chosen for appointment of commissary stewards from various sources. A yeoman who is able to pass the prescribed examination for commissary steward does not necessarily make an efficient commissary steward. It would be far better to draw stewards from the commissary branch only, making it a requirement that they should have served at least two years in the rate of cook or baker before undergoing examination for commissary steward. A gunner's mate is seldom, if ever, rated from the engineer's force, and the present system of rating yeomen as commissary stewards is as radical a change in duty. The commissary steward should be able to perform any duty that he directs the cooks and bakers under his charge to do.

In brief, the conclusions drawn from this argument are:

(a) Present instruction of younger pay officers at the army school, so as to fit them for supervision of a training school for enlisted men. Upon their further advancement and experience detailing them as instructors in the Navy Pay Officer's School, and including a thorough commissary course for officers in that excellent institution.

(b) A thorough course of four month's instruction in *practical* commissary work for all enlisted men in the commissary branch who cannot on enlistment demonstrate, in practical work, a thorough familiarity with all branches of their trade; having for instructors not only practical cooks and bakers and commissary stewards in the navy, but experienced civilian cooks, bakers, and hotel stewards.

(c) The selection of commissary steward from *only* those men who have entered in the commissary branch as cooks or bakers and who have served at least two years in that grade.

(d) Further, men who are graduates of the school should be given acting and then permanent appointments in the various rates, giving them the same recognition shown to men in the artificer branches.

The following courses of instruction, modeled on the courses used in the army school at Fort Riley are suggested:

COURSE OF INSTRUCTION FOR COOKS.

Ship's galley and its equipment: fires, control of heat and ovens; cleaning and care of range and kitchen utensils; paring potatoes; washing and preparing fresh vegetables; preliminary instruction in the preparation of other parts of the navy ration for dinner only.

Meats, cutting the fore and hind quarter for specific kinds of cooking;

trimming and preparation; use of stock pot and dripping pan; assisting in preparation of other parts of the ration for breakfast and dinner only.

Assisting in the preparation and cooking of dinner and supper only.

General cooking, covering all parts of the navy ration alternating daily, by roster, in the preparation and cooking of breakfast and supper; assisting ship's cooks in the preparation of dinner.

Alternating daily, by roster, in the preparation and cooking of dinner; assisting ship's cooks at breakfast and supper.

Alternating by roster, as chief cook, in the preparation of all meals for the ship. Making light breads, pastry, and puddings.

The last month will be a review of work of the preceeding three months, the course being completed by a thorough written examination covering the entire course. This will include computing the ration return for 100 men and making up a bill of fare based on this ration return.

BAKER'S COURSE.

General outline of course will be explained by the officer in charge, and theoretical instruction will be given by him from time to time, as occasions require.

1. Making of yeasts and potato ferment.

2. Setting of sponge in evening and making dough following morning, using 50 pounds of flour, and Fleischmann's Yeast.

3. Repeat No. 2, and make head yeast.

4. Repeat No. 2, and make potato ferment.

5. Making straight dough with 50 pounds of flour early in the morning, using potato ferment.

6. Repeat No. 5, and make stock yeast.

7. Repeat No. 5, and make potato ferment.

8. Making straight dough in evening, using Fleischmann's Yeast.

9. Repeat No. 8.

10. Setting sponge in evening for 400 pounds of flour. Fleischmann's Yeast, making dough following morning, with machine.

11. Making sponge in morning, using potato ferment, and making dough when sponge is ready.

12. Repeat No. 11.

13. Make dough, using 50 pounds of flour in morning, from potato ferment, from yeast made by yourself.

14. Make two kinds of fancy bread, using 10 pounds of flour.

15. Making of buns, rolls, etc.

16. Making pie paste and pies from the same.

17. Practical test of all processes. A 25-pound straight dough will be made with no help from any source but personal note-book. The following day a 25-pound sponge and dough will be made with help of note-book only.

During the course each process must be completed at least once before practical test, from beginning to end, from the making of dough to the baking of bread in the oven.

PROFESSIONAL NOTES.

Prepared by Professor PHILIP R. ALGER, U. S. Navy.

SHIPS OF WAR, BUDGETS, AND PERSONNEL.

AUSTRIA.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Erzherzog Friedrich.. ...	10,600	Trieste.	Under trial.
Erzherzog Ferdinand-Max.	10,600	"	Building.

FRANCE.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Démocratie.....	14,865	Brest.	Launched May 2, 1904.
Justice.....	14,865	La Seyne.	" Oct. 27, 1904.
Vérité.....	14,865	Bordeaux.	Building.
Liberté.....	14,865	St. Nazaire.	Launched April 19, 1905.
Danton	18,000	Brest.	Ordered.
Mirabeau	18,000	Lorient.	"
Voltaire	18,000	....	Authorized.
Diderot	18,000	....	"
Condorcet.....	18,000	....	"
Vergniaud	18,000	....	"
Armored Cruiser.			
Ernest Rénan,....	13,644	St. Nazaire.	Launched April 9, 1906.
Jules Michelet.....	12,550	Lorient.	" Aug. 31, 1905.
Victor Hugo.....	12,550	"	Under trial.
Edgar Quinet	13,644	Brest.	Building.
Waldeck Rousseau.....	13,644	Lorient.	"

TRIALS OF THE REPUBLIQUE AND PATRIE.—The new first-class battleships *République* and *Patrie* have successfully completed their trials. The Minister of Marine, M. Thompson, came from Paris specially to attend the final full-speed trial of the former, which took place off Brest, in which dockyard the ship has been built. The trial results of the *République* were as follows: With the central engine alone working and making 39 revolutions and developing 1500 I. H. P., and three boilers in use, a speed of 7.5 knots was maintained. On the 24 hours' run, with the engines developing 10,332 I. H. P., and the two side ones making a mean of 102.5 revolutions and the center one 93, a speed of 16.8 knots was maintained, with a coal consumption per square meter of heating surface of 64 kg. (141 lbs.), and per I. H. P. per hour of 746 gr. (1⅝ lbs.) the contract allowing for 800 gr. (1¾ lbs.). With the engines developing 18,000 I. H. P., 500 H. P. over the contract, a speed of 18.8 knots was

maintained for four hours, with a coal consumption of 123 kg. (271 lbs.) per square meter of grate surface per hour. At the final full-speed four hours' trial the engines developed 19,626 I. H. P., being 2126 H. P. over the contract, a speed of 19.15 knots was maintained, being more than a knot over the contract, with a coal consumption of 117 kg. (258 lbs.) per square meter of grate surface.

The trials of the *Patrie*, which was built by the La Seyne firm at their yard near Toulon, were also completely successful. The results were as follows: With the central engine alone working and developing 1233 I. H. P., a speed of 7.9 knots was maintained, with a coal consumption of 590 gr. (1¼ lbs.) per I. H. P. per hour; with the engines developing 11,660 I. H. P., during a 24 hours' run, a mean speed of 17.8 knots was maintained, with a coal consumption of 715 gr. (1½ lbs.) per I. H. P. per hour; at the preliminary four hours' full-speed trial, with the engines developing 17,350 I. H. P. and making 114 revolutions, a speed of 19 knots was maintained, with a coal consumption of 835 gr. (1¾ lbs.) per I. H. P. per hour; at the final official four hours' full-speed trial, with the engines developing 17,859 I. H. P., 359 H. P. over the contract, a speed of 19.125 knots was maintained, being rather more than a knot over the contract, with a coal consumption of 115 kg. (253½ lbs.) per square meter of grate surface, the contract allowing for a consumption of 120 kg. (264½ lbs.)

The gun trials of both ships were equally satisfactory, twelve rounds being fired from the four 12-inch guns in each ship, thus effectually disposing of the rumor which has been circulated that owing to a miscalculation the turrets were too small, and the guns could not be worked, which would delay the completion of the two ships for months, as it would be necessary to remove the old turrets and build new ones.—*United Service Institution.*

THE ERNEST RÉNAN.—The following description of the French armored cruiser, *Ernest Rénan*, the largest yet laid down in France, has been abridged from the *Engineer*.

Her general dimensions are as follows: Length at load water-line, 515 feet; breadth, extreme, at load water-line, 70 feet 1 inch; draft on a displacement of 13,644 tons, 26 feet 10 inches; total coal capacity, 2300 tons; estimated speed, 23 knots.

Protection is afforded by a complete water-line belt 12 feet 3 inches in width, having a maximum thickness of 6 inches for about 296 feet amidships, the thickness is gradually decreased to 4 inches and 3.2 inches at the stem and stern. The two strakes of the belt side armor extend from 45 feet below the water-line to 7 feet 7 inches above the same, from the lower to the upper protective decks. The heavy side armor strake has a maximum thickness amidships and at the water-line of 6 inches, tapering gradually to the lower edge, where it is only 5.2 inches, and from amidships to the ends where the thickness is 4 inches and 3.2 inches; the second strake is 5.2 inches thick amidships, and only 3.2 inches at the stem and stern. Abaft the belt side armor extends only to a few feet aft of the rudder, and there an athwartship armored bulkhead extends to both sides and from the lower to the upper protective decks. An armor strake extends from the stem to the fore casemates, and reaches from the top of the water-line belt to the lower edge of the gun deck, and is 2.2 inches in thickness.

There are two armored athwartship bulkheads extending from the shell plating at the ends of the casemates to the 7.7 inches barbettes, and 6 inches thick throughout. There are two protective decks extending from the stem to the stern, the lower deck being flat amidships, but sloped at the sides throughout and at each end. It will be built of 1½ inch plating throughout, with nickel steel of 1.84 inches on the flat, and of 2½ inches on the slopes. The upper protective deck is flat, and will

be built of 1½ inch double plating. The side protection is completed by a coffer-dam extending from the upper protective deck level to the lower protective deck level, and worked from end to end of the vessel. Behind this coffer-dam there is a water-tight bulkhead worked from stem to stern; the space between the coffer-dam and the water-tight bulkhead is used in its upper part as a passage for repairing breaches in the coffer-dam, and in its lower part as a waterway for the water coming through the breaches. Teak backing is fitted behind all the side armor. The space between the belt side armor, the water-tight bulkhead and coffer-dam, and the two protective decks, is called "la tranche cellulaire de protection"; its numerous compartments are either empty, or packed with cellulose or other approved water-excluding material, or filled with coal, fresh water, etc. The ammunition passages, funnels, air pipes, etc., going through the "tranche cellulaire," are protected by an annular coffer-dam extending from the lower to the upper protective decks. Above the upper protective deck is the "gaillard deck," or gun deck, extending from stem to stern; above this deck is the spar deck, extending from the stem to the astern turret. On the spar deck is a large bridge.

The conning-tower is on the bridge deck, between the fore turret and the fore mast. The conning-tower and shield will have a thickness of 8 inches. An armored tube 35.6 inches in diameter will extend from the base of the conning tower to the protective deck, and will be 5 inches thick throughout.

The engines will be three in number, 4-cylinder, triple-expansion type, developing combined 36,000 I. H. P., steam being provided by 42 boilers of the Niclausse type, placed in water-tight compartments.

The coal bunkers are to have a maximum capacity of about 2300 tons. With the ordinary stowage of 1354 tons the steaming radius will be at 10 knots 7500 miles, and with 2300 tons 12,000 miles. At full speed the steaming radius is to be 1026 and 1630 miles respectively with ordinary and maximum supply. A certain quantity of liquid fuel will be shipped in special tanks and in the double bottom.

The armament will consist of four 194-mm. (7-inch), twelve 164.7-mm. (6.5-inch) guns, twenty-four 47-mm. (3-pounder), and three 37-mm. (1-pounder) guns. The battery will be mounted as follows: The 194-mm. guns in pairs in two electrically-controlled, balanced, elliptical turrets on the center line, one forward on the spar deck, the other aft on the gun deck. The 164-mm. guns, of which eight are in electrically-controlled, balanced, elliptical turrets on the spar deck side, four on the port, and four on the starboard side, two at each end of the superstructure. The 194-mm. barbettes extend from the protective deck to the spar deck for the fore barbette, and to the gun deck for the aft barbette, and consist of 6.4-inch armor in front, and 4¾-inch in the rear; the barbettes will not have any special framing, the connection of the armor with the decks being sufficient. The turrets will have a front plate 6.4 inches thick, rear plate, 4¾ inches thick, and top plate 1.6 inches thick, with the upper tube 3.2 inches thick, and lower tube of 1.2 inches in thickness.

The 164 mm. barbettes will be 5½ inches thick in front, and 4 inches in the rear, with the upper tube 2¾ inches thick, and the lower tube .8 inch thick; the turrets will have front plate 5½ inches thick, and rear plate of 4 inches, and top plate 1.6 inches thick.

The armor casemates extend from the top of the water-line belt to the lower edge of the gun deck for the forward casemates, and is 5½ inches in thickness; the athwartship bulkheads at the ends of these casemates extend from the shell plating to the 194-mm. barbettes, and are 6.6 inches thick throughout. The casemate armor around the 164 mm. guns on the gun deck is of nickel steel, the front plate is 5.6 inches in thickness; the splinter and inner plates are 2.4 inches thick, the floor and top plates are 1.2 inches thick.

The casemate guns are arranged to fire right ahead and right astern

respectively. Two 7.7-inch guns and six 6.5-inch guns will fire right ahead or right astern, and four 7.7-inch guns and six 6.5-inch guns will fire on the broadside. There will be six 3-pounder guns on the gun-deck, ten of the same size on the spar-deck, and eight on the bridges. There will be two submerged torpedo tubes of 18 inches diameter.

Magazine bulkheads adjacent to heated compartments, such as fire-rooms, engine-rooms, dynamo-rooms, etc., are provided with air spaces. The shell rooms for the 7.7-inch guns are at the foot of the barbettes; the magazines and shell rooms for the 6.5-inch guns and small guns are between the main engine and fire-rooms compartments, and are so arranged that about one-half of the ammunition will be carried at each end of the ship. The ammunition will be conveyed directly by hoist from the ammunition rooms, or ammunition passages, to the deck where they are required, or as near that as possible. The hoists will be driven by electric motors; for transporting the ammunition, trolleys on rails will be provided in the handling rooms, passages, and shell rooms.

The keel of the cruiser was laid down on the 21st of October, 1903; she was launched on the 9th of April, and she will, it is said, be delivered to the navy on the 5th of August, 1908.—*United Service Institution.*

THE FRENCH NAVAL PROGRAM.—The difficulty experienced by our French neighbors in settling upon a program of naval construction and carrying it through is emphasized once more by the discussions now taking place upon the proposals that will shortly be presented to the Chamber of Deputies by the government. The program of 1900, which was to have given to the French Navy its old relative strength, is not even yet terminated, nor is it ever likely to be in its entirety. The tampering with the program so far destroyed the aims of those who are responsible for it, that when M. Thomson succeeded to M. Camille Pelletan as Minister of the Marine, and took counsel with the Conseil Supérieur, he saw that the only way of getting out of the muddle was to make a clean sweep, as far as possible, and start upon an entirely new policy of naval construction. For the new proposals represent nothing less than an entire change in the French policy, a change so drastic that it could not fail to provoke a great deal of criticism. At the moment when M. Thomson proposed to put on the stocks six battleships of 18,000 tons, in anticipation of the program he was bringing forward, he seemed to have the almost united support of the Chamber. This was due mainly to the impression caused by the able report of M. Charles Bos, who showed, in view of the lessons of the Russo-Japanese naval battles, that France was imperilling her security in neglecting the construction of heavy and powerfully-equipped units. The Minister had no difficulty in obtaining the sanction of the Chamber to start upon the new battleships during the present year. For the moment the party who had always been dazzled with the possibility of annihilating big and powerful fleets with torpedoes and submarines was silenced. Before venturing to attack the Minister's program, in view of the purely subsidiary part played by torpedoes in the naval battles on the high seas in the Far East, the advocates of a flotilla of small boats waited to see the results of the maneuvers carried out in the Mediterranean. These were organized principally in order to test the efficiency of the submersibles and submarines. Attacks made upon Toulon were repulsed by these little craft, and at the termination of the maneuvers Admiral Fournier expressed himself as a strong believer in the submersible boat. This revived the hopes of the party who regard the expenditure of money upon a battleship as a deplorable waste, when such a vessel can be sent to the bottom by a boat costing less than a tenth of the sum. They endeavored to make out that Admiral Fournier himself recognized the superiority of the submarine over the battleship. The old controversy accordingly broke out afresh, and the new program seemed to be jeopardized by the opposition of the submersible enthusiast.

The persistency with which a large section of the French public are pinning their faith in the submersible as a weapon of attack against the battleship may be explained in two ways. In the first place, France regards herself as practically the inventor of the submarine and submersible boats—at least, in their practical form—and in view of their early promises it was firmly believed that they would prove an infallible weapon against the attack of the strongest fleet that could be brought against them. Secondly, France is finding it more and more difficult to equalize her budget on account of the steadily increasing expenditure in all departments, while the revenue remains almost at a standstill. At such a moment, any method of increasing the fighting power of the navy without entailing any further considerable sacrifice would be hailed with satisfaction. This is what the advocates of the submersible claim to be capable of doing. When the British Government decided upon reducing the expenditure upon naval constructions, and held out the hope that a general limitation of armaments would result, the French decided that they were unable to follow this example unless Germany was disposed to follow the lead of Great Britain. Moreover, this proposed reduction of armaments was taken as a text by French submersible engineers upon which to base arguments showing that France had no particular need to join in any movement for the limiting of naval constructions, since the advance she had obtained with the submersible gave her an advantage which she could not afford to lose. We repeat these arguments to show that the submersible mania is not yet dead, and that the government may be expected to meet with a considerable amount of opposition in their attempt to carry through the new program. Further evidence of the gathering strength of the opposition of the submersible party is seen in the report of M. Henri Michel upon the proposed naval credits. In his verbal report before the Commission of the Marine, M. Henri Michel has distinctly sided with the submersibles. In a word, M. Michel proposes to undo all the work that has been mapped out by M. Thomson with the assistance of the Conseil Supérieur de la Marine, as he asks the Commission to reduce the number of battleships to be put upon the stocks from six to three, by which means there will be an economy of 16,391,000 f., and a return to the old order of things which was so ruthlessly condemned in the report of M. Charles Bos.

The suggestion of M. Michel to reduce the number of battleships is all the more extraordinary seeing that a bill has already been passed authorizing the Minister to put the six battleships on the stocks. If this work is to be suspended it can only be done by the passing of another bill. M. Thomson, however, is firmly determined not to allow any tampering with his program if it can possibly be avoided. He should by now have already started upon the construction of the six battleships, but they have been delayed pending an inquiry into the efficiency of the turbine as a means of propulsion for such vessels. The report of the results obtained with the *Dreadnought* have removed any hesitation upon this point. It has therefore been decided to equip the new battleships with steam turbines, for which orders have already been given out, and work will doubtless be pushed forward as rapidly as possible, so that by the time the estimates come up for discussion in the Chamber of Deputies, the program will be so far advanced as to admit of no further modification so far as the battleships are concerned.—*Engineer.*

ADMIRAL FOURNIER'S REPORT ON THE 1906 MANEUVERS.—Contrary to precedent, the report of last spring's naval maneuvers has just been made public, doubtless because partial citations had led to the belief that Admiral Fournier condemned armored squadrons.

The praises which the admiral showers upon his officers and crews were well merited. The maneuvers took place at a time of great heat; the ships were overworked; the officers had to give proof of great en-

durance; and the men, especially the engineers and firemen, had to support excessive fatigues. Yet there was not a single accident and all showed remarkable zeal.

Admiral Fournier's report can be divided into two parts, of which the first treats of the tactical exercises and the second of the torpedo-boats and submarines.

The tactical evolutions of the fleet enabled a trial to be made of the new signal codes which are soon to replace the old ones. Not less than five years have been required to reach this end, the work having been begun under the direction of Admiral Gervais and of the lamented Admiral Merleaux-Ponty, but having been retarded, or even wholly stopped, during the Pelletan administration. The new signals caused no misunderstandings, a subject for congratulation, since, as the admiral says, the experiment was a bold one. But the main interest of the maneuvers was the test of battle exercises "in line of battle of divisional groups,"—methods of formation aptly called "Fournier tactics." Opinions are much divided as to the eventual efficiency of this system of tactics, the characteristic feature of which is that the three ships of each division form an irregular group which, while following the movements of the commander-in-chief, aims to keep its guns bearing upon the enemy. Thus it is hoped to render signals and compass bearings unnecessary. As may be supposed, the admiral attributes to this system all desirable qualities—simplicity, certainty, possibility of concentration of fire upon an adversary, while avoiding such concentration on his part, etc., etc.

Admiral Fournier has been reproached for not having tested the efficiency of his tactics against an opposing squadron; it is claimed that no important conclusions can be drawn from a combat in which the movements of an imaginary enemy have been arranged beforehand. The admiral devotes a chapter of his report to justifying his procedure in this respect—time was lacking to do more than was done. "It would have been unreasonable to have proceeded otherwise . . . next year the commander-in-chief will be able to allow more of an initiative to the supposed enemy."

The second part of the report consists of a warm plea in favor of the development of flotillas of torpedo boats and submarines, both offensive and defensive. The successes of the defensive flotillas of Bizerta and Marseilles during the three days, July 17, July 31, and Aug. 2, are there confirmed. The submarines succeeded on the average twice apiece on the first two days, and three times apiece on the third day, in approaching without being discovered, in position to launch their torpedoes, to within a few hundred meters of the objective. We must not conclude, however, as a certain school would have us, that in case of a real war all the battleships would have been sent to the bottom. It is not sufficient for a torpedo-boat by night, or a submarine by day, to get within torpedo range,—it is also necessary for the torpedo not to miss, and, moreover, to strike the enemy so as to inflict a mortal injury. Consequently, the admiral does not condemn armored squadrons, but concludes that these two types—the battleship and the submersible—under the conditions of modern naval warfare, precisely because of their extreme dissimilarity, lend themselves to an efficient joint action, particularly of value as far as France is concerned. A fighting fleet can only attain its highest efficiency by combining in its composition battleships and submarines.—Translated and abridged from *Le Yacht*.

SUBMARINES AND SUBMERSIBLES.—France has actually in service 30 submarines and seven submersibles of different models.

A.—The *Lutin*, of unhappy memory, belongs to the series of four submarines of the type *Farfadet* (*Farfadet, Lutin, Konigan, Gnôme*), begun at Rochefort in June, 1899, and completed in 1903 on the plans of Chief Engineer Maugas. These four, as well as three of the type *Morse*

(*Morse, Francais, Algérien*) constructed at Cherbourg in 1898-1902 upon the plans of Chief Engineer Romayzotti, are developments from the *Gustave-Zédé*, built at Toulon in 1889 on the plans of M. Gustave Zédé. The four *Farfadets* were all at Bizerta,—they are pure submarines, cigar-shaped, and of circular section, 41.35 meters long, 2.90 meters in diameter, 185 tons' surface displacement, and about 8 per cent buoyancy. They have four torpedo tubes. Designed for 12 knots surface and 8 knots submerged speed, they have never been able to reach 9 knots surface and 6 knots submerged speed. The type *Farfadet*, the type *Morse*, and the *Gustave-Zédé* have but one motive power, an electric motor worked from accumulators.

B.—The *Anguille* belongs to the series of 20 small submarines of the type *Naïade*, whose construction was ordered begun on April 3, 1901. Four have been built at Cherbourg, six at Rochefort, and ten at Toulon, on the plans of M. Romayzotti. They were not all finished till the spring of 1906, a period of five years, which is absurdly long for such small boats. They are 23.50 meters long, 2.30 meters in diameter, 68 tons' surface displacement, and about 5 per cent buoyancy. They also are pure submarines, though an attempt was made to increase their radius of action by giving them gasoline motors in addition to the electric motors and accumulators. The results have been pretty poor—their gasoline motors have frequently broken down and a recent ministerial order (July, 1906) forbids their further use and the further putting of gasoline on board of them. Consequently they used electric motors only in their recent successful participation in the defence of Toulon and Marseilles during the last naval maneuvers. Their small size and lack of habitability condemn them to a defensive rôle, within short distances from their base. These 20 boats have about 8 knots surface and 6 knots submerged speed. They are now stationed 3 at Dunkerque, 5 at La Pallice, 8 at Toulon, and 4 at Saigon, but it has been proposed to send some of those at Toulon and La Pallice to other stations.

C.—The *Cigogne* belongs to the series of 13 submersibles of the type *Aigrette*, begun at Cherbourg and Toulon in May, 1902, and the construction of 11 of which was countermanded by M. Pelletan in September of the same year. The remaining two, the *Aigrette* and *Cigogne*, were finished in 1906—they are upon the plans of Chief Engineer Laubeuf. They are submersibles of the type *Sirène*, enlarged, having 36 meters length, 4 meters beam, 175 tons surface displacement, and the great buoyancy (30 per cent) which characterizes the submersible type. They have a Diésel heavy-oil motor for surface use, an electric motor with accumulators for under-water use. Their speed is about 9 knots surface and 6⅓ knots submerged, and they have 4 torpedo tubes.

The competitive tests of February, March, April, 1905, between the *Aigrette* and the submarine *Z*, a development from the *Lutin*, clearly showed the great superiority of the submersible over the submarine type in the matter of speed and sea-keeping qualities. These qualities make the submersible an offensive boat, while the submarine will always be useful in coast defence.

The boats designed for under-water use which are now actually under construction or trial number 28—the submarine *Y*, 6 submarines of the type *Emeraude*, the submersible *Omega*, and 20 submersibles of the type *Circé*.—Translation from *Le Yacht*.

THE UTILITY OF SUBMARINE BOATS.—The report which has just been made to the War Minister of France by Admiral Fournier, the vice-president of the Superior Naval Council and commander-in-chief of the naval forces, on the subject of the recent maneuvers of the French Navy, strongly advocates submarine boats. The maneuvers, it may be said, were directed, firstly, to illustrate problems connected with naval opera-

tions on the high seas; and, secondly, to enable a study to be made of coast defence. The admiral expresses his satisfaction with the new tactics employed, and compliments those responsible for them. That part of the report dealing with the operations for coast defence is, perhaps, the most suggestive, and in it Admiral Fournier, according to the *Moniteur de la Flotte*, refers to the almost unquestionable efficiency of submarine boats. The maneuvers prove that ordinary vessels would be forced to take all possible precautions when within range of powerful coast-defence artillery, and would also be subjected to severe treatment by submarine boats. But submarine boats might operate with impunity so far as the land guns are concerned. In his opinion, it will be necessary in future to construct as many submersible, or submarine boats as possible—boats for offensive operation, with large radius of action, and other craft, purely for coast defence. The submarine boat is, in his opinion, the best auxiliary imaginable to large ships of the line, and consequently he supports the view that what is wanted are large battleships with many small craft, either surface or submarine but preferably the latter, delivering torpedo attack. It is pointed out that France two years ago had 34 submarine boats for defence, and 16 for attack; now there are 80 in use, or in course of construction. This year 18 boats are being laid down for attack, having a displacement of 398 tons. Among them there will be, for experimental test, one or two of a tonnage of from 800 tons to 900 tons. The 390-ton boats will be laid down as soon as the prototype of the class has passed through her diving trials. It is important, therefore, to note that France has in use, in course of construction, or projected, 80 submarine or submersible boats, while we in this country have only 40; our boats, according to the recent Admiralty return, range in displacement up to 313 tons, with a submerged speed of 10 knots and a surface speed of 13 knots. The United States have nine submarines in service, with several more building, and Russia has 23, including several bought during the war. Japan has seven, Italy has thirteen, and Germany is building one, but the budget for the current year decides that £250,000 per annum shall be spent for some years on submarines. It is obvious that the opinion in favor of the submarine is developing quickly and extensively.—*Engineering.*

NEW SUBMERSIBLES AND DESTROYERS.—The French Minister of Marine has ordered 16 submersibles to be put in hand, of which, it is said, three will be constructed at Cherbourg, seven at Rochefort, and six at Toulon. Eighteen boats were begun last year, and the Budget of 1906 made provision for 20 in all, so that four more have to be put in hand. Those now ordered will displace 398 tons, and be 160 feet long, with 16 feet 4 inches beam, and will have a maximum surface speed of 12 knots with 700 I. H. P. They will have seven torpedo discharges, and a complement of 24 men. It is intended that the remaining four boats of the program shall be of a much larger class, and it is said that they may even reach a displacement of 800 tons. Six destroyers are also to be begun in private yards—the *Hussard, Voltigeur, Spahi, Tirailleur, Chasseur,* and *Carabinier.—Army and Navy Gazette.*

Le Yacht states that the 16 submersibles recently ordered are similar to 18 begun in 1905, and have the following dimensions—length 51.12 meters, beam 9.97 meters, draft 3.12 meters, displacement 398 tons, I. H. P. 700. The four boats remaining to be ordered will be of 800 tons displacement; two will be built at Cherbourg and one each at Rochefort and Toulon.

TYPES OF FRENCH TORPEDO-BOATS.—Seventy-two torpedo-boats have recently been constructed for the French Navy. Fifteen of these were built at Havre, twelve at Rouen, eighteen at Nantes, ten at Bordeaux,

nine at the Creusot Works at Chalons-on-Saône, and the remainder in the dockyards. As is customary with the majority of vessels of this class, their lines are such that when in motion they glide upon the surface of the water rather than cut through it. It is claimed for them they are remarkable, considering their displacement, for speed, resistance, evolutionary properties, offensive power, and habitability.

The hull, which is of high-resistance steel throughout, is divided into six compartments by means of five water-tight bulkheads. The bow compartment is apportioned to the crew. The second and third compartments are taken up by the boilers, of which some are of the Normand and some of the du Temple-Guyot type. Each boiler has a capacity of 1000 horsepower. The fourth compartment contains the engines, which have three cylinders and are triple-expansion, and the auxiliary machinery, dynamo, pumps, etc. The officers' quarters are aft of the engines, and the stern compartment contains stores. The conning tower is on the deck forward. It is protected with 1-inch plates of nickel steel.

The following table gives the leading particulars of these boats, which vary slightly, according to the yard in which they have been built. In the case of all of them, however, their length is the same, *i. e.*, 39 meters, say, 124 feet 8 inches, and their contract speed is the same, *i. e.*, 26 knots. Apparently their speed on trial varied between 25.65 knots in bad weather to 27.4 knots in smooth water.

DETAILS OF FRENCH TORPEDO BOATS (LATEST TYPE).

Displacement, tons	97.507	97.490	97.808	99.059	99.67
Breadth, extreme	13 ft. 11 in.	13 ft. 11 in.	13 ft. 11 in.	14 ft. 10 in.	13 ft. 11 in.
Draft astern, extreme	8 ft. 7 in.	8 ft. 8 in.	8 ft. 8 in.	8 ft. 4 in.	8 ft. 7 in.
Horsepower	2000	1900	2000	2000	2000

The bunker capacity is about 11.2 tons, and the steaming radius at 10 knots is said to be 1800 miles, while at full speed it is 200 miles. With a horsepower of 900—*i. e.*, with one boiler not being pressed quite to its full capacity—a speed of 14 knots is attained with the engines running at 179 revolutions per minute.

It will be noticed that these boats only have one propeller. Formerly twin screws were preferred by the French naval authorities, and a speed of 30 knots aimed at. In the present craft, however, it would appear that speed has been sacrificed to better sea-going qualities.

The armament consists of three 17¾-inch torpedo tubes. One of these tubes is placed in the bows. The other two are amidships, and can fire on either broadside. Six torpedoes will be carried.

This year two armored destroyers are to be built. They are to be of 450 tons displacement, and will be protected as were the armored torpedo boats constructed on what is known as the 1903 system. It may be of interest if we give a few details of these latter boats. The displacement is 185 tons. The boilers and engine rooms are protected with 1-inch nickel steel plates on the sides and extreme bulkheads. The deck armor is ¾ inch thick, and so is that of the conning-tower. There are three 19-inch torpedo tubes and two 1¾-inch quick-firing guns. These boats have "du Temple" boilers and two sets of four-cylinder triple-expansion engines each driving a propeller. An example may be given of the strength with which these boats are constructed. Recently one was on her trials when something went wrong with the steering gear. She ran at full speed on to a rock. The whole of the fore part was crushed and folded up like a concertina. She remained fast on the rock, but was eventually towed off. On examination in dry dock it was found that without the strength due to her armor the boat must have been totally lost. The fore part to the first bulkhead was taken out and a new bow

fitted. She subsequently passed through her trials and is now in full service. The principal dimensions of these boats are as follows:

Length between perpendiculars	147 feet 8 inches
Beam, extreme	16 " 11 "
Depth	11 " 8 "
Draft astern	8 " 8 "
Horsepower	1200
Trial speed	from 26½ to 28.7 knots

Since the first of the series of 72 torpedo-boats mentioned at the commencement of this article were on their trials some improvements have been made in their steering apparatus. A balanced rudder is placed forward just below the keel. This is of considerable dimensions for a boat of such size, and has, we understand, been found very efficient.

A new type of balanced rudder, the invention of M. Normand, is to be supplied with every new torpedo boat. It is stated that when steaming straight ahead a boat with a rudder of this type keeps her course without continual small corrections being made with the rudder.—*Engineer.*

GERMANY.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Pommern	13,200	Stettin.	Launched Dec. 2, 1905.
Hannover	13,200	Danzig (Schichau Works.)	" Sept. 26, 1905.
Q	13,200	Kiel.	Building.
Schlesien	13,200	Danzig.	Launched May 28, 1906.
Ersatz Bayern	19,000	Wilhelmshaven.	Ordered.
" Sachsen	19,000	Kiel.	"
Armored Cruisers.			
Gneisenau	11,600	Bremen.	Launched June 14, 1906.
Scharnhorst	11,600	Hamburg.	" March 22, 1906.
E	16,000	Kiel.	Ordered.
Protected Cruisers.			
Danzig	3,200	Danzig.	Launched Sept. 23, 1905.
Koenigsberg	3,200	Kiel.	" Dec. 1905
Stuttgart	3,420	Danzig.	" Sept. 22, 1906.
Ersatz Wacht	3,420	Stettin.	Building.
Nürnberg	3,420	Kiel.	Launched Aug. 28, 1906.
Ersatz Pfeil	3,420	Dantzig.	Building.
" Komet	3,420	Hamburg.	"

The attention which has for some time past been focussed on the German Navy, will be largely increased early next year by the further reorganization of the fleet under Prince Henry of Prussia, and the organization of active battle squadrons cruising in the North Sea and the Baltic. The striking force of the German Navy will comprise 16 battleships and 3 armored cruisers, to be increased within 12 months or so to 23 armored ships. The *Daily Telegraph's* naval correspondent points out that "no other navy—except that of Great Britain—has shown such a vast increase in its fighting strength immediately ready for war. The displacement of the home battle fleet continuously at sea has quadrupled since the beginning of the century, while the personnel always under war training in the battle fleet will be also four times as great as it was. At the same time, it must be borne in mind that at present the Germans keep in commission a number of battleships which cannot be regarded as first-class, side by side with the vessels of the British fleet, such as the *Dread-*

nought, of 17,900 tons, the *Lord Nelson* and *Agamemnon*, of 16,500 tons each, the eight ships of the *King Edward VII* class, each of 16,350 tons, men-of-war of tremendous fighting power.

The constitution of the fleet according to this authority will be as follows: 16 battleships and 3 armored cruisers, organized in homogeneous classes, thus:

FIRST SQUADRON.

	Completed for sea.	Displacement (tons.)	Main Guns.
Wittelbach, Wettin, Zahringen, Mecklenburg.	1902-3	47,000	16-9.4 in. 72-5.9 in.
Wilhelm II, Wilhelm der Grosse, Karl der Grosse, Frederick III	1898-1901	44,820	16-9.4 in. 72-5.9 in.

SECOND SQUADRON.

Braunsweig, Elsass, Preussen, Hessen, Lothringen	1904-5	66,000	20-11 in. 70-6.6 in.
Deutschland, Pommern, Hannover	1906	39,000	12-11 in. 42-6.6 in.

CRUISER SQUADRON.

York, Roon	1905	19,000	12-8.2 in. 10-2.9 in.
Frederick Karl	1904	9,000	

In addition, the fleet will include seven small cruisers, two torpedo craft, as despatch boats; two torpedo flotillas for instruction; two torpedo flotillas for maneuvers; and one torpedo flotilla in reserve. The battle fleet in reserve will include two obsolescent battleships—*Wörth* and *Weissenberg*—and two coast defence ships.—*Page's Weekly.*

The armored cruiser to be built under the 1905 program will be of 16,000 tons' displacement and carry 10 28-cm. guns, or six less than the 19,000-ton battleships.

The following ships will enter into active service during 1907: The second and third of the *Deutschland* class of battleships, the *Pommern* and the *Hannover;* the two 11,600-ton armored cruisers of 22.5 knots' speed, *Gneisenau* and *Scharnhorst;* the two last small cruisers of the *Bremen* class, *Danzic* and *Koenigsberg;* the three first of the following class of small cruisers, *Nürnberg, Stuttgart* and *Ersatz Wacht;* 12 torpedo-boats, and 3 submarines.

These additions will make the German naval force consist of 22 battleships (later than the *Brandenburg*), 8 armored cruisers, 22 small cruisers (later than the *Gazelle*), and 68 torpedo-boats of 300 tons or more.—*Le Yacht.*

Admiral von Koester, who now retires practically from active service, is in his 61st year, has had a long and distinguished career, which has been recognized by the Kaiser's bestowal upon him of the Order of the Black Eagle, the highest decoration which he has in his power to confer. Since Admiral von Koester first assumed command of the Maneuver Fleet in the spring of 1894, the German Navy has made enormous strides. When he took over the command from Admiral Schröder,

the fleet consisted of eight ships forming two divisions, with two cruisers: the 1st Division, composed of the four battle-ships of the *Sachsen* class, which were even at that time nearly obsolete, and the 2d Division, of the *Kœnig Wilhelm* and *Deutschland*—both older ships still—with the *Brandenburg* and *Friedrich der Grosse*, the two first ships of a new type. The total displacement of the fleet amounted to 66,367 tons, manned by 5000 officers and men. The active battle-fleet of to-day, the command of which he is vacating, consists of two squadrons of eight battle-ships each, with a total displacement of 191,200 tons and manned by 10,500 officers and men. In place of two small cruisers, the Cruiser Division now consists of 3 armored cruisers, and 6 smaller ones, with a total displacement of 46,000 tons, and manned by 3200 officers and men. In place of only one second-in-command, as formerly, the new commander-in-chief of the Battle Fleet has five flag officers under him.—*United Service Institution.*

In relation to the launch of the German small cruiser *Nürnberg*, which was built under the name of *Ersatz Blitz, Ueberall* draws the attention of its readers to the persistence with which Germany has continued to build small protected cruisers of this class, beginning with the *Gazelle*. In no other navy is such a policy pursued, except that Japan is now laying down some small vessels of an analogous class. The improved *Gazelles* are undoubtedly a remarkable class, and the later vessels displacing 3400 tons, and having a speed of from 23.5 to 24 knots, are a great advance upon the original type. But *Ueberall* evidently feels some doubt as to the wisdom of constructing so many vessels of the class, for there are now 22 built or in hand, and remarks that if more money had been available, trials might have been made with other classes. These small cruisers are to be used for scouting and torpedo-destroying purposes, as also for despatch duties.

Another of the German small cruisers was launched in September, namely, the *O*, built at Danzig, which has received the name of *Stuttgart*. She is of the improved *Gazelle* class, and a sister of the *Nürnberg*. These vessels displace from 3400 to 3500 tons. They are 354 feet 3 inches long, with 54 feet 6 inches beam, and carry ten 4.4-inch, eight 2.2-inch and four machine guns, besides having two submerged torpedo tubes. The speed is to be 23½ knots. The *Nürnberg* has Thornycroft-Schultz boilers. The *Stuttgart* will be furnished with turbines supplied by a German company, and not of the Parsons type. It is intended to test this new cruiser with the *Ersatz Wacht*, which, we understand, is to have Parsons turbines. The mining transport *Nautilus* has also been launched at the Weser Yard, Bremen. She is not protected against gun fire, but is strengthened at the waterline to resist the pressure of ice. She is of a special type, and it is hoped that she will begin her trials in November. A sister vessel is in hand.—*Army and Navy Gazette.*

The German naval authorities, in view of the fact that the Russian ships at the battle of Tsushima were so heavily laden with coal that the armor belt in many instances was below the water line, and consequently shot received on the water-line produced bad leaks and irreparable damage, have instructed the admirals and officers commanding battleships and armored cruisers to report what measures can be taken to lighten vessels so as to bring the armor belt higher above the water, thus affording more broadside protection.—*N. Y. Herald.*

The first submarine boat of the German Navy was recently launched from the Germania Shipyard at Kiel. Its displacement is 180 tons, its speed 9 knots, and it is meant to carry a crew of twelve hands.—*Engineering.*

Le Yacht states that the first of the series S138-S149 of torpedo-boats has just been launched from the Schichau works at Elbing. These boats are of 530 tons' displacement and with 10,000 H. P. are expected to have a speed of 30 knots.

GREAT BRITAIN.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Dreadnought	18,000	Portsmouth.	Commissioned.
B	18,000	Portsmouth.	Building.
C	18,000	Devonport.	"
D	18,000	.....	Authorized.
Lord Nelson	16,500	Jarrow (Palmer).	Launched Sept. 4, 1906.
Agamemnon	16,500	Glasgow (Beardmore).	" June 23, 1906.
Africa	16,350	Chatham.	Under trial.
Britannia	16,350	Portsmouth.	" "
Hibernia	16,350	Devonport.	" "
Armored Cruisers.			
Minotaur	14,600	Devonport.	Launched June 6, 1906.
Shannon	14,600	Chatham.	" Sept. 20, 1906.
Defence	14,600	Pembroke.	Building.
Warrior	13,500	Pembroke.	Launched Nov. 25, 1905.
Cochrane	13,500	Glasgow.	" May 20, 1905.
Natal	13,500	Barrow.	Under trial.
Achilles	13,500	Newcastle.	" "
Invincible	15,000	Newcastle.	Building.
Inflexible	15,000	Clydebank.	"
Indomitable	15,000	Glasgow.	"

H. M. S. DREADNOUGHT.—The new battleship *Dreadnought*, which has awakened world-wide interest, is now running her official steam trials in the English Channel. With the results of the trials we hope to deal next week, and will confine ourselves for the present to a review of some features of the ship as a fighting unit of the fleet.

We are freer to deal with these elements than was the case when we first described the vessel in February last, because she has now passed from the closely-guarded secrecy of the dockyard to the open sea, where she meets the attack of the photographic camera—as fatal to official secrecy almost as the guns of the *Dreadnought* will be to foreign naval aggressors. There are ten 12-inch guns—the most formidable armament yet fitted to any ship. Each of the guns is of 45 calibers in length, firing an 850-pound shot, with a velocity to give a muzzle energy of something like 48,000 foot-tons. We have time and again referred to the courage displayed by Sir John Fisher in thus entirely eliminating the intermediate-sized gun, and confining the primary armament to weapons effective at long range. This has increased the size and cost of the battleship, but the gain in fighting efficiency more than compensates for the higher cost, especially as experience at the Battle of the Sea of Japan demonstrated that future actions were certain to be fought at long range, and that the smashing effect of the projectile must be considered as well as its power of penetration. Many writers have, however, raised doubts as to the propriety of dispensing with the quick-firing intermediate-caliber gun, and Captain Mahan has recently returned to the attack. He lays stress upon the disadvantage resulting from damage to the upper works, and especially the funnels, whereby the steaming power of any ship may be materially reduced, influencing, as a consequence, the speed of the whole fleet. He seems, however, to have forgotten that, where artificial draft is fitted for the steam boilers, the whole of the funnel might be shot away without the steaming capability of the boilers being materially affected, and this point has been duly considered in the *Dreadnought* and the later ships for the British fleet.

The aim in the placement of the guns on the *Dreadnought* was to utilize the greatest possible proportion of gun-power for broadside and end-on

fire, while ensuring that the blast from one gun would not affect the gun-crew in any adjacent gun-house. These desiderata, which have not always been realized in foreign ships, have too often been omitted in paper comparisons of gun-power. It is idle to multiply guns if their arc of training is deficient, or if the fire of any one gun may at any time mask that of another, or if the blast renders dangerous the occupancy of any adjacent turret. Another difficulty is the arrangement of magazines to suit an ideal disposition of guns, especially in a modern ship where high speed involves the use of an extensive area for machinery. In the arrangement of magazines in the *Dreadnought*, Sir Philip Watts has shown great ingenuity and experience; but on this we are not free to give details.

The forward pair of 12-inch guns is on a high forecastle, the weapons being about 35 feet above the load-water line. What may be termed the wing bow-chasing guns—two 12-inch guns in a barbette on each side—are on the upper-deck level, nearly 100 feet abaft the bow guns, and in order that these may fire in line with the keel the forecastle is cut away, forming an embrasure. This arrangement of bow guns corresponds to that adopted in all of the recent British cruisers, but is here adopted for the first time in battleships. The forecastle guns have an angle of fire of about 270 degrees, while the two wing guns have an angle of quite 185 degrees. Their location so far aft, and the fact that the sides of the upper deck have been kept clear of all obstructions on each side aft from these gun-houses, have justified this wide arc, and will enable the guns to be used, if found desirable, as additional stern-chasing weapons. This, however, will be an exceptional condition.

Between the aft funnel and the main-mast, there is a pair of 12-inch guns in barbette mountings on the upper-deck level. These guns have an arc of training of quite 90 degrees on either broadside. We have heard the contention made that the firing of these guns 45 degrees forward of the beam might result in their fire being masked by the wing guns; but it may safely be assumed that the two guns in the center line between the funnel and the main-mast will only be trained and fired on the same bearing as the forward broadside guns, so that the objection raised is negligible. Abaft the main-mast there are the usual stern barbette guns on the upper-deck level.

There are thus three pairs of guns in the center line of the ship, with two pairs of wing guns placed rather forward of amidships, and eight of the ten guns can be utilized for broadside fire. This latter is the important measure of the gun-power of the *Dreadnought*, because broadside fire is the dominant factor in fighting efficiency. It is possible to conceive of a vessel having 12 or 16 guns so placed that her gun-power would not be as effective as the weapons in the *Dreadnought*.

The disposition and arc of training of the various guns has suggested a new arrangement of carrying the boats. These are compactly grouped around the funnels, a condition which is quite satisfactory for peace times. In war the boats will be cast overboard, so that they may not involve fire dangers. The masts have been built as tripods, an arrangement first introduced in the *Lord Nelson* and *Agamemnon*. This entirely dispenses with the shrouds, which would have obstructed the training of some of the guns. Moreover, the tripod form reduces the possibility of complete destruction of the mast by quick-firing guns; it reduces the target, and even were one leg to go, the others would stand with guys suitably placed. This is important, because the masts carry the gun-sighting stations and the receiving wires in connection with the etheric telegraphic system. These are now very important items in a fighting ship, and make masts indispensable. When certain temporary fittings are removed, the only obstruction on the deck in the after part of the ship will be the base of the tripod of the mainmast, with the bridge surrounding it; the capstans, etc., are all removed when the vessel is cleared for action.

The *Dreadnought* is well equipped with machine-guns for repelling torpedo and submarine-boat attack; there are twenty-seven small quick-firing guns, most of them 12-pounder weapons of new design and greater power than those of this type hitherto carried on battleships. These are mounted on the upper platforms located between the two funnels. The navigating bridge, it will be seen, has four platforms above the upper deck, the two uppermost levels being carried, as in all the later ships, on forged steel columns. The top bridge over the chart-house is about 60 feet above the water-line. Under it is the main bridge, and below it is located the forward conning-tower, built of 11-inch armor. This is reached through a trap-door from above, so that there is no opening through which splinters of shells may find their way into the tower. Owing to the location of the wing 12-inch guns, this bridge does not extend the full width of the ship, and the position from which the "lead" is cast is on the upper deck.

The officers' quarters are arranged on the main deck in the vicinity of the bridge, and a convenient promenade may be provided for the admiral on the one side, and the officers on the other, on the ledge on the main-deck level formed by the embrasure, in addition to the forecastle, which here takes the place of a quarter-deck. Abaft there is a small bridge, close to the mainmast for carrying a searchlight, etc. Here there is also a conning-tower formed of 8-inch armor, but ordinarily the ship will be navigated and fought from the forward bridge.

As to the armor, it is 11 inches in thickness in the central part of the ship from considerably below the water-line to the upper deck. The thickness, however, is reduced at the ends to 6 inches at the bow and 4 inches at the stern. The redoubt armor varies in thickness from 11 inches to 8 inches, the guns being protected by 11-inch armor. The thickness of the protective deck varies from 1¾ to 2¾ inches. There are many novel features in the design of the ship, associated with the arrangement of magazines, the supply of ammunition, and the training machinery for the guns, the work for which was carried out by Messrs. Vickers Sons and Maxim, Limited, and Sir W. G. Armstrong, Whitworth & Co., Limited. There are obvious reasons, however, why we should not disclose any details regarding these.

The contract for the machinery of the *Dreadnought* was placed with Messrs. Vickers Sons & Maxim, and on their behalf a considerable part of the work has been done by the Parsons Company. The propelling engines are steam-turbines driving four shafts, their collective horsepower being estimated at 23,000 indicated horsepower, with the turbines making 320 revolutions per minute, with steam at an initial pressure of 185 pounds. The fitting of four shafts enabled the power to be divided into two separate units. In each engine-room there is one high-pressure and one low-pressure main ahead turbine, a cruising turbine, and one high-pressure and one low-pressure astern turbine—five in all. The high-pressure main and the high-pressure astern turbines drive the wing shafts, while the cruising and the low-pressure ahead and astern turbines are on the inner shaft in each engine-room. The low-pressure ahead and low-pressure astern turbines are within the same casing. All the shafts and propellers turn outwards when going ahead. There are eighteen boilers of the Babcock and Wilcox type, designed to work at a pressure of 250 pounds to the square inch.

It may be interesting, in concluding this article, to refer briefly to the vessels which have borne the name of *Dreadnought* in past naval epochs, and a review of the work of these ships suggests that the Admiralty have very properly named this new and highest conception of destructive science the *Dreadnought*. We give a list of the nine successive ships of the name, showing the gradual increase in the length and tonnage, as well as in the

SUCCESSIVE DREADNOUGHTS.

Launched. Year.	Length. ft.	in.	Breadth. ft.	in.	Depth of Hold. ft.	in.	Tons.	Guns, Number.	Heaviest Shot. lbs.	I. H. P.	Crew Number.
1572	92	0	....		....		400	29	60	....	380
1654	116	0	34	6	14	2	732	58	..	....	355
1690	140	6	38	6	16	7	910	60	18	....	346
1710	....		....		....		933	60	24	....	365
1742	144	1	41	7	16	11	1,903	60	24	....	400
1801	185	0	51	0	21	6	2,111	98	32	....	743
1808[1]	205	0	54	6	23	2	2,616	120	32	....	886
1875	320	0	63	9	26	9	10,820	26	809	8,210	475
1906	490	0	82	0	26	6	17,900	37	850	23,000	655

[1] Took name *Dreadnought* in 1856.

number of officers required to man the vessels in warfare. Eight of these ships have seen active service. The first took part in the destruction of the Spanish Armada; the second gained renown in the Duke of York's victory over the Dutch fleet off Lowestoft; the third was present at the victory off Cape La Hogue; the fourth was among the fleet which gained the day off Cape Passaro in 1718; the fifth was engaged in the French wars of 1744, and had some prizes to her credit; the sixth was present at the Battle of Trafalgar, and captured a Spanish 74-gunner. The others, of later date, have experienced more peaceful times. The guns carried in each ship suggest the enormous advance made with ordnance, and this is more strikingly evidenced by the fact that although the *Dreadnought* of 30 years ago had four guns firing an 809-pound projectile, these had only a muzzle energy of 13,930 foot-tons—little more than a fourth of the striking power of the 56-ton gun of to-day, firing an 850-pound projectile. On the other side of the ledger we have, unfortunately an enormous increase in the cost of ships. The *Dreadnought* of 1742 was built for £21,350, the 1875 ship cost £620,000, whereas the battleship of to-day is costing £1,797,497, according to the latest official estimate.—*Engineering.*

THE STEAM TRIALS OF THE DREADNOUGHT.—The telegram of congratulation from His Majesty, in connection with the splendid results attained on the trials of the new battleship *Dreadnought*, was at once an evidence of the King's interest in science generally and in the navy in particular, and it may be accepted also as a fitting public acknowledgment of what is undoubtedly a great achievement in constructional engineering. We have already referred to the great credit due to the Admiralty technical staff and to Portsmouth dockyard for the building of the *Dreadnought* in 16 months from the date of the first issue of drawings; we therefore confine ourselves here to the significance of the work associated with the propelling machinery. In the first place there will be increased satisfaction at the enterprise of the Admiralty in adopting the steam-turbine, now that a searching test has justified this step. The Admiralty were quite conscious of the fact that the steam-turbine system of propulsion has disadvantages; but were convinced that the advantages to be gained altogether outweighed them, and acted accordingly. Easy of working, facility of regulation, freedom from vibration, and economy at high powers were all demonstrated. As to constructional advantages, the area occupied by the turbines, and their weight, are practically the same as for reciprocating engines. A reduction of 15 per cent is made in the boilers, and the total installation is less in weight and space occupied by this amount of boiler reduction. As the engines can be placed lower than in the case of

reciprocating machinery, the protection is more effective, and the lower center of gravity facilitates the placing of the great array of heavy guns on the upper deck without reducing the stability of the vessel. As regards stopping and starting and maneuvering, the turbines have proved themselves most satisfactory; while in respect to working up to full speed, a great tactical advantage was established: the vessel was on her official full-speed trial an hour and a quarter after leaving the anchorage.

The trials prescribed were those which long experience has proved adequate to test the steaming capability of warship machinery. There was the usual 30 hours' trial at 20 per cent of full power, the 30 hours' run at about 75 per cent, and the 8 hours' run at full power, with the addition of four trials, each of three hours' duration, in order to arrive at the economy of the installation when steaming with the cruising turbines at various rates of power from the maximum obtained by the use of the by-pass valves, and at the lower powers obtained when not using them. But instead of dealing with the trials in chronological order, it may, perhaps, be better to review the salient points in the results achieved.

First, as regards the generation of steam, the results achieved were undoubtedly satisfactory. The boilers, 18 in number, of the Babcock and Wilcox type, were constructed by the contractors for the machinery—Messrs. Vickers Sons & Maxim, Limited. The evaporation at all trials worked out to between 10 pounds to 10.2 pounds per pound of coal per hour, which, under the service conditions prevailing during the trials, must be regarded as an excellent result. Again, the good workmanship was attested by the low loss of water. Even when running at full power the loss was only equal to one ton per hour per 8000 horsepower developed, while at 75 per cent of the maximum power the result was still more favorable. The boilers are of the standard Babcock and Wilcox type, with "wheel" baffling. The ratio of heating surface to grate area is 34.75 to 1, and on the trials nearly 17 horsepower were developed per square foot of grate for a lengthened period. The air-pressure in the stokehold was 1.2 inches.

As regards the turbine installation, the extreme variation in the speed of warships in commission introduces conditions inimical to economy. It has time and again been proved that the turbine at full or over-load is more economical than the reciprocating engine when design and manufacture are completely satisfactory; and this was again proved in the *Dreadnought*, where the coal consumption on the full-power trial of eight hours' duration was 1.51 pounds per shaft horsepower per hour. During the course of the week's steaming it was decided to ascertain the maximum power which could be realized, and 28,000 horsepower was developed, according to the torsion-meter; this gives an overload—a power above the maximum provided for in design—of 5000 horsepower; and the important point is that the coal consumption when thus overloaded equalled about 1.4 pound per shaft horsepower per hour. In comparing the coal-consumption results with the rate for similar ships having reciprocating engines, allowance must be made for the difference in the method of determining the power. In turbine machinery this is arrived at with the assistance of the Denny & Johnson torsion-meters, which measure the torque on the respective shafts. In the reciprocating engine power is "indicated" from within the cylinder, so that the total includes in such case such power as may be lost in friction in the engines and thrust-blocks; with turbines the power taken is that passing through the shafts. It is difficult to put a value on this loss by friction—it varies so much—but probably it is 8 per cent or 10 per cent of the total, so that the coal consumption of the *Dreadnought* on her full-power official trial should be reckoned at 1.4 pound, and at overload at 1.3 pound for comparison with the consumption for piston engines in preceding ships. In the seven ships of the *King Edward VII* class already tried, the coal consumption averaged 1.92 pound per indicated horsepower per hour, and

in no case was the consumption less than 1.8 pound. A further proof of the efficiency of the *Dreadnought's* turbine system is afforded by an examination of their steam consumption. This on the full-power trial was just over 14 pounds per shaft horsepower, and including the consumption in the auxiliary engines, the total was 15½ pounds per horsepower per hour. In the battleships of the *King Edward VII* class the corresponding figure was 18.14 pounds; the power in this latter case, too, includes the 8 or 10 per cent lost in friction. Here, therefore, there is again a very striking evidence of the economy of the turbine at full power. This condition would naturally be that continuously obtaining in merchant practice.

This full power is in warships only supposed to be used in case of emergency—such as a sudden spurt to overtake the enemy or to engage in a running fight. But in the *Dreadnought* everything worked so splendidly that there need be no such limit in the period of maintenance of full power, especially with oil fuel, for burning which this vessel is fitted. The "continuous steaming power" of the ship, however, is officially regarded as 75 per cent of the full power, and in the 30 hours' trial at this power there was, as was to be expected, a slight falling off in economy, as compared with the full-power result, because, as we have already pointed out, the turbine is most efficient when at full or at over-load. On this trial, however, when the power developed was nearly 17,000 horsepower, the coal consumption was 1.7 pound per shaft horsepower per hour, or, allowing for the difference between shaft and indicated horsepower, 1.53 pound per indicated horsepower. On the corresponding trial of the seven battleships of the *King Edward VII* class the average was 1.74 pounds. It will, therefore, be seen that here the economy of the turbine system is quite 10 per cent. The steam consumption was also 10 per cent less; and there is no doubt that experience with the turbine machinery will enable these results to be improved upon in commission.

Unfortunately, in the life of a warship the proportion of time during which the vessel is making full speed is small relatively to her total steaming time, and, as we have said, the variation in speed complicates the problem very materially. When a steam-turbine is run at light load, but at the same speed as at full load, its efficiency is but little affected. In the case of a marine turbine this is impossible; moreover, such turbines are, as a rule, underspeeded even at full load, owing to propeller considerations, so that further reduction of speed for low power has an unfavorable effect on the economy. To meet this condition there are introduced small turbines, designated cruising turbines, which are brought into action for low speeds. These constitute practically a lengthening of the turbine; but the length, or, more strictly speaking, the number of rings of blades, should increase in inverse proportion to the square of the reduction in speed if the efficiency is to be the same at low as at high power. Thus, to get down to half speed and still maintain the efficiency, the cruising turbine should multiply the number of rings of blades in action by nearly four. This, however, is practically impossible, especially on board warships, where the space, particularly below the load water-line, is so valuable in connection with the carrying of a sufficiency of ammunition and projectiles. In some of the turbine-driven warships, notably in the *Amethyst*, high and low-pressure turbines were fitted for cruising, as well as for full-power steaming, and all four were worked in series at low powers. In the *Dreadnought* it was decided to make two separate engine-rooms, each with an independent steaming unit, the inner shaft having a cruising as well as a low-pressure ahead and a low-pressure astern turbine; while the outer shaft has a high-pressure ahead and a high-pressure astern turbine. Inspection of the turbines at the works of the makers suggested that the cruising turbines were about eight feet in external diameter, the high-pressure ahead turbines rather more, the low-pressure ahead turbines about 11 feet, and the high-pressure astern turbine the smallest.

At low power the steam is passed into the cruising turbine, thence into the high-pressure ahead turbine, and finally into the low-pressure ahead turbine, from which it exhausts through the low-pressure astern turbine to the condenser, the low-pressure ahead and astern turbines being within one casing. For anything near half power this arrangement is favorable, and gives a result generally more economical than with reciprocating engines, but not so good as at full power. At the lower powers the necessarily low rate of evolution of the propeller results in the steam being throttled to such an extent that the wire-drawing involves considerable loss in power, unless a very small cruising turbine is used, so that the higher initial pressure would be maintained. It is probable that on the *Dreadnought* the loss from this cause at very low powers might be 20 per cent, and although this is partly counterbalanced by slight superheating, the loss is still considerable. The steam consumption, and consequently the coal consumption, at low power was greater than on the high-power trials already referred to, having been 2.56 pounds of coal per shaft horsepower per hour; even so, this has often been exceeded in battleships with reciprocating machinery, notably in the case of the *King Edward VII.* It is possible, however, that the arrangement in the *Amethyst* might be more satisfactory—namely, the working of the two cruising turbines in series. This, however, would forfeit the advantage of two entirely independent units of propelling machinery at low powers, and might be considered objectionable from the deck officers' point of view. The other alternative is to increase the number of cruising turbines to four, having two in each engine-room working in series; but it is probable that limitations of space might prove a difficulty. All of this establishes what we have time and again pointed out, that in warship design there are conflicting considerations, so that the uniform success attained in merchant-ship practice cannot always be realized. Throughout the trials of the *Dreadnought* a vacuum of between 27 inches and 28 inches was maintained. The system producing this satisfactory result was that introduced by Messrs. Weir in connection with their dry-air pump, and fully illustrated in our article on the Cunard liner *Carmania* (*Engineering*, vol. lxxx., page 724).

As regards the power developed and the speed realized, the results exceeded anticipation. At one-fifth power the speed was over 13 knots. At 16,900 horsepower the rate was 19.3 knots—a very satisfactory result for this power, equalling the full-power performance of the vessels of the *King Edward VII* class. On their trial the indicator showed 18,000 to 18,500 horsepower, which is probably comparable with the 16,900 shaft horsepower of the *Dreadnought;* but while the speed and power are therefore equal, the *Dreadnought* has a considerably greater displacement—17,900 tons, as compared with the 16,350 tons in the preceding battleships. At the full designed power of 23,000 horsepower it was anticipated that the vessel would steam 21 knots, and it is another remarkable evidence of the accuracy of calculation that this was easily realized. The mean power on the eight hours' trial was 24,700—an excess over the designed power of 1700—while the horsepower realized when on the measured mile west of Plymouth gave a mean speed over four runs of 21.6 knots. It is well known that the proportioning of an efficient propeller for turbine-fitted ships is one of the unsolved problems, and although the Admiralty have in the *Dreadnought* realized the anticipated result, we hope that in the interests of science, if not also of the navy, a series of practical tests will be undertaken when the vessel goes into commission in order to test various forms and proportions of screw propellers. The results in the County and *Drake* classes of cruisers justify any expenditure that may be incurred, as in both these instances higher speeds were realized as a consequence of propeller experiments.

An important point in connection with the adoption of the turbine has reference to the maneuvering power of the ship. The adoption of ten

12-inch guns in each ship of such a class gives an enormous offensive power for a short battle-line, and, the steering of the ships being satisfactory, confers a great advantage on the Admiral of the Fleet in the changing of the battle-line, apart altogether from the benefit which must accrue from concentration of fire. This question of the manipulation of the vessel had very serious consideration in connection with the design, and Sir Philip Watts introduced for the first time two rudders placed at about 12 feet apart, the stern framing corresponding, so that the inner propellers work in free water immediately forward of each propeller; the dead-wood was cut away to facilitate this. The wing propellers are located eight feet forward of the inner screws, with stern-brackets corresponding to the arrangement usually adopted in naval ships for twin-screws.

Each rudder has its independent steering-gear, consisting of the usual right- and left-handed threaded shaft, carrying two nuts with connecting-rods to a crosshead on the rudder-head. This right and left-handed screw-shaft is operated (as with ordinary single-rudder ships) from engines mounted on the after bulkhead of the engine-rooms. In each engine-room there are two vertical engines, each with 11-inch cylinders and 11-inch stroke, with a coupling, so that either of the two may be used for working the shaft. This gear and also the capstan and anchor engines and gear have been constructed by Messrs. Napier Brothers, Limited, of Glasgow, who have supplied such machinery for so many of our large warships and merchantmen. Special interest was taken in the working of this double-rudder system, and it was found throughout the trials that the gear worked with remarkable precision, the ship answering the helm more rapidly than has even been the case with recent ships. The steering, etc., trials were most favorable.—*Engineering.*

TRIALS OF H. M. S. DREADNOUGHT.—The following notes on the performances of boilers, propellers, and turbines of the *Dreadnought* will be found interesting:

Boilers.—Her boilers are, as is well known, of the Babcock and Wilcox type, and have given very remarkable results. Indeed, it is doubtful if there are any records of trials of the same duration and rate of steam production per square foot of heating surface in any similar group of boilers with the same economy. Comparing earlier and later boilers of the same type, the *Dreadnought* shows that, as found in nearly all other water-tube boilers, the large unit always gives greater economy than the small unit. The following table, based on official trials, shows this clearly:

H. M. Ship	Boilers new in	No. of boilers	Total Heating surface	Duration, hours	Results of full power trials		
					Weight of steam produced		Coal:—Welsh, calorific value
					Per hour per ... of heating surface.	Per ton of coal	
			sq. ft.		lb.	lb.	
Sheldrake	1897	4	9,103	8	4.82	16,508	14,310 B. T. U.
Espiegle	1901	4	4,040	9	6.13	19,219	14,500 "
Hermes	1903	12	26,520	7	6.91	19,129	14,300 "
Dreadnought.	1906	18	55,400	8	6.94	22,467	Not known

These results are obtained by measuring the condensed steam, but as the "make up" is water pumped into the boiler and lost between the feed pump and measuring tank, after being turned into steam, this might also be added, and in the case of the *Dreadnought* would give 7.07 pounds of steam, produced per square foot of heating surface per hour, for the same coal bill.

The propellers.—A correspondent has pointed out that it was to be expected that the inner, which are the after, propellers would have always revolved faster than the outer ones. All the propellers appear to be of about the same dimensions, viz., diameter 8 feet 10 inches, pitch 8 feet 4½ inches, and it will be noted that the slip of the wing propellers seems to be less at low speeds, about the same at 19.4 knots, and less at 21.6 knots, than the inner propellers. And though apparently each propeller was intended to transmit the same power, yet a glance at the figures we gave in our issue of October 12 will show that this was only approximated to at 19.4 knots, and that at 21 knots the high-pressure turbines operating the wing shafts gave only about 40 per cent of the total power. Evidently there is much to be said for those who advocate that the wing turbines and propellers should exchange places.

The engines.—The engine results leave no doubt of the advantage of the "closed exhaust."

The tables of initial pressures in the various turbines offer problems to students to find the efficiency of the steam. The cruising turbines are designed to have four expansions, the high-pressure ahead turbines six expansions, the low-pressure ahead turbines seven expansions, and the low-pressure astern turbines five expansions. But a more momentous problem is that of propeller thrust. It will be observed that the port inner shaft is credited with transmitting an average of 7447 horsepower at 333.3 revolutions during the eight hours' full power trial, and at 351.4 revolutions per minute there might be danger of the internal clearances of the rotors disappearing.

All four tunnel shafts have a minimum external diameter of 10½ inches, and internal diameter of 6¼ inches.

Mean speed.—As to the mean speed obtained during the eight hours' trial, a correspondent points out that from the figures we published the mean speed seems to be 20.993 knots for 24,712 horsepower, obtained by equating the revolutions of each shaft, which gives a mean speed due to inner shafts 20.811 and 20.042, and to outer shafts 21.814 and 21.304. A more correct mean seems to be obtained by allowing for the "mean slip" of all shafts between 19.4 and 21.6 knots, and this gives a mean for the eight hours of 21.129 knots, which would accord with the designed speed of 21 knots for 23,000 horsepower. The slip per cent of the various shafts at the speeds mentioned are: Starboard inner 21.041 and 25.324, port inner 20.369 and 24.738, starboard wing 21.690 and 20.815, port wing 21.716 and 19.871. Evidently new propellers should be tried, sanguine prophets giving the ship 23 knots when so perfected.—*Engineer.*

TRIAL OF H. M. S. DREADNOUGHT.—The performances of the *Dreadnought* are being watched with manifest interest by all who wish for the well-being of our navy. She is the outcome of long experience, and includes various experiments, the success of which has yet to be fully demonstrated. We might cite many things apparently new in her, yet old. But, confining our attention to the machinery, there is no doubt of the magnitude of the step, from reciprocating to turbine engines. Technical men may be divided into Moderates and Progressives, or into the "James Watt cult," and "Turbinists," and only a few regard warship machinery in the correct light, which is the speed given by a certain weight of machinery burning a certain weight of coal. The cost of the machinery need only be considered when it has to earn dividends.

She has eighteen Babcock and Wilcox boilers, each of twenty elements, arranged in three stokeholds, and fitted for burning oil fuel in conjunction with coal. The grate surface is 1560 square feet, the heating surface 55,400 square feet, and the tops of her funnels are about 85 feet above the fire-bars. Each stokehold has a tube, about 30 inches diameter, which can be used for raising ashes or wounded, by electric lifts. See's ash ejectors are also fitted. Each stokehold is self-contained.

The main condensers have 26,000 square feet of cooling surface, the auxiliary condensers 6000. There are four propeller shafts, all the four capable of going ahead or astern in pairs. The wing shafts have each two turbines on them, one high-pressure ahead turbine and one high-pressure astern turbine; the inner shafts have each three turbines on them, cruising, low pressure ahead, and low-pressure astern. The wing propellers are ahead of the inner propellers. The construction of the rotors is generally known; these have been carefully balanced under steam, and can run up to a speed of 400 revolutions per minute, and each shaft has a governor fitted.

It may be of interest to mention that each of the cruising turbines has 39,600 blades in it, and the total number in all the turbines is in proportion. One feature in turbine machinery is the immensity of the exhaust pipes, each of the *Dreadnought's* exhaust pipes being a rectangle 12 feet by 4 feet—this for 11,500 horsepower. The system of dry and wet air pumps is well known.

The turbines are of the following sizes:

	ROTORS. Diameter.	Length.
Cruising	5 feet 8 inches	8 feet 6⅜ inches
High-pressure ahead	5 feet 8 inches	8 feet 7½ inches
Low pressure ahead	7 feet 8 inches	6 feet 6 inches
High-pressure astern	5 feet 8 inches	3 feet 1½ inches

The low-pressure astern rotor is, as usual, in the same casing as the low-pressure ahead one. The necessity for accurate balance is apparent when it is mentioned that the actual weights of the revolving rotors on one shaft amount to 32 tons. The boilers were designed to burn 34,500 pounds of coal per hour at full speed. The results show how this has been approximated to, and though the designed power was exceeded—as at 23,000 horsepower she only just neared the designed speed—yet there was little danger if the intended 320 revolutions per minute were passed so far as damage to rotors was concerned.

One very important feature about the Dreadnought is that her complement of men is much smaller than that of the Terrible or Magnificent, her crew all told numbering but about 655 as against 900 and 820 of the former.

The horsepower of the engines was measured directly by means of Denny and Johnson's torsion meters. This depends for its action upon the measurement of the angular distortion of the shaft itself. The shaft is thus converted into a transmission dynamometer, and the power passing through it is easily found. The apparatus consists of two discs or wheels of gun-metal keyed to the shaft at a suitable distance apart. Each disc carries one or more—generally one—permanent magnet, with the pole sharpened to a knife edge projecting from its periphery. Immediately underneath each disc is a stand containing a number of independent coils of insulated wire. Wires from the coils are led to a telephone which has differential winding. It is so arranged that if the shaft rotates without any distortion the permanent magnets pass simultaneously two coils, one in each stand, which are paired. The result is that absolutely simultaneous currents pass through the differential windings of the telephone, and the receiver does not speak. Suppose now that the shaft twists, then

one magnet will pass one of a pair of coils before the other, and the telephone will tick for each one. But, by means of a suitable switch and contact studs, various coils out of the numbers on the stands can be paired together, and there is little difficulty in finding two which are the correct angular distance apart. As soon as this happens the telephone ceases to speak. The angular distortion of the length of shaft taken is then read off the instrument, and, being multiplied by a constant, gives the power that is being transmitted. This instrument, which has proved itself to give accurate results in many trials, is made by Kelvin and James White, Limited, of Glasgow.—*Engineer.*

A SQUADRON OF DREADNOUGHTS.—The prospects are that in 1909 no continental nation will have in fighting condition one single ship of the *Dreadnought* type; whereas, says *Engineering*, if the British Admiralty continue the rate of construction attained with the ship to be tried this week, they will then have one squadron made up of six *Dreadnoughts*, and, in addition, a squadron composed of eight ships of the *King Edward VII* class, and two *Lord Nelsons*.

The first squadron will have 60 12-inch guns, with the enormous advantage of a short and easily manipulated fighting line, while the second squadron will have 40 12-inch guns and 52 9.2-inch guns. Both will be enormously superior to any squadron of an equal number of ships of any other navy. By 1908, too, the British nation will know whether foreign nations accept the olive branch which it has held out in this year's naval policy, by a relaxation of naval expenditure, without any diminution of determination to ultimately maintain mastery of the sea. If this desire for limiting armaments is not reciprocated, then there will be equal unanimity in continuing building operations to maintaining our supremacy at all costs. There should be no mistake about this view.

The Sea Lords, who, after all, continues *Engineering*, have the confidence of the nation, will not waver as to the vital principle of supremacy. Foreign nations, and notably the German people, may realize that their continuance in the development of their naval program—involving as it does in their case not only an enormous sum for ships, but something like 10 millions sterling for the widening of the Kiel Canal—cannot win even the mastery of the German Ocean—the ambition of the Admiral of the Atlantic.—*United Service Gazette.*

NAVAL CONSTRUCTION.—The ships which have recently been put into the water reduce the number of vessels on the stocks so considerably as to have attracted attention. And it appears to be worth while, therefore, to glance for a moment at the actual condition of construction. There is not at the present time any battleship on the stocks, although three new *Dreadnoughts* are to be begun before the end of this financial year. It may, we think, be assumed that, although these three vessels have not yet arrived at the stage when their keels are laid, orders have been placed for material and possibly for armor. It will be remembered that in the case of the *Dreadnought* herself similar orders were given out, and a very large expenditure incurred before the ship began to be put together at Portsmouth. Of the battleships which have been launched but are not yet completed, the *Lord Nelson*, recently put into the water at Messrs. Palmer's yard at Jarrow, and the *Agamemnon*, which was put afloat earlier in the year by Messrs. Beardmore at Glasgow, are all we have in hand. Then there are the vessels which, in various stages of completion, are either about to make or have just finished running their trials. These are four in number, the *Dreadnought*, the *Britannia*, the *Hibernia*, and the *Africa*. Of these four vessels, the *Britannia*, which was launched in December, 1904, is practically complete. The *Hibernia*, launched at Davenport, in June, 1905, and the *Africa*, launched at Chatham, in May of the same year, should soon be in active service, while the *Dreadnought*,

launched in February of this year, has begun her trials. It may be said, therefore, that we are turning out three battleships a year, and if the *Dreadnoughts* now to be put in hand are built in anything like the same time as the name ship of the class, we should continue to do so.

Turning to the subject of cruisers, very much the same condition of affairs is apparent. There are the three new ships, *Invincible*, *Indomitable*, and *Inflexible*, all well advanced on the slips, decked in, and must soon be ready for launching. The only other cruiser not yet in the water is the *Defence*, laid down at Pembroke in February, 1905, and with regard to this vessel there appears to be no reason why she should not be launched at any time the authorities desire. Of her sister vessels the *Shannon* has just been launched, and the *Minotaur* was launched earlier in the year. These vessels are still in a completing stage. They will all three make and complete their trials early next year, which, remembering that they belong to the program of 1904-05, will not be otherwise than creditable. Of the ships of the previous program, there are the *Achilles*, at the Armstrong's Works; the *Cochrane* completing by the Fairfield Company; the *Natal*, in a similar stage at Vickers; and the *Warrior*, completing at Pembroke. All four of these vessels are in a very forward state, and their trials will certainly be finished, and the ships probably in commission before the end of the financial year. It would certainly be an advantage if all vessels of the same class could invariably be brought forward for trial about the same time, for it would be more useful to have them all in active service together than to obtain such slight benefit as might arise from correcting in the sister vessels such mistakes as were discovered in the first ship tried. We have had recently, both during our own maneuvers and in the incidents of the war in the Far East, examples of the ill effects of putting into the same squadron ships of different dates, and therefore of different speeds. Lord Selborne's celebrated aphorism, "Gunnery, gunnery, and again gunnery," has for its parallel a similar maxim about homogeneity; for it is quite certain that without something like homogeneity in his squadron no commander can expect to get the full value of his ships.

The small craft in hand, destroyers and submarines, although not nearly as numerous as in some past years, make a much better show than their larger and heavier companions. None of the vessels of the 1905-06 estimates are as yet in commission, although several of the coastal destroyers are in the water. They include the twelve boats, *Cricket*, *Gadfly*, *Firefly*, *Glow-Worm* and *Dragonfly*, all of which have been put afloat, with the *Gnat*, *Grasshopper*, *Greenfly*, *Mayfly*, *Sandfly*, *Spider* and *Moth*. Then there are the ocean-going torpedo-boat destroyers of the same program, *Afridi*, *Cossack*, *Gurkha*, *Mohawk*, and *Tartar*. The latter are, of course, much larger vessels, but they should be ready for commission with the fleet next year. At present they are all in various stages of construction, but it is quite likely that they will go afloat very quickly after one another. Of the same program there is the special ocean-going destroyer *Swift*, building by Messrs. Cammell, Laird & Co., at Birkenhead. With these may also be mentioned the *Velox*, a turbine fitted destroyer, and the Yarrow motor boat recently purchased. The above appear to be all the destroyers for which orders have actually been given, and so far no contracts are known to have been entered into for the construction of the destroyers of the 1906-07 program. In this program there are five ocean-going destroyers, of which two have since been struck out. There were also twelve coastal destroyers, all of which have been struck out. And it is reported that the three boats to be built will be of the class of the *Swift*, of 36 knots speed. The submarines have also been reduced in number, four out of the twelve which it was proposed to lay down having been postponed. Where the remaining ones will be built, or when they will be begun, is also uncertain.—*Army and Navy Gazette.*

THE SHANNON.—The first-class armored cruiser *Shannon*, built at Chatham, was successfully launched on September 20. One of a trio, of which the others are the *Defence* and *Minotaur*, the *Shannon* was laid down on January 3, 1905. Her principal dimensions are: Length over all, 519 feet; extreme breadth, 75 feet 6 inches; draft forward, 24 feet 6 inches; aft, 25 feet 6 inches; displacement, 14,600 tons; indicated horsepower of engines, 27,000; speed, 23 knots. The armament will consist of four 9.2-inch breech-loading guns, ten 7.5-inch guns, eighteen 12-pounder 18-cwt. guns, two 12-pounder 8-cwt. guns, and five .303 Maxims, while in addition she is fitted with five torpedo tubes. When commissioned she will carry a complement of 778 officers and men. The *Shannon* has cost nearly £1,250,000.—*United Service Gazette.*

THE LORD NELSON.—The launching of the new British battleship *Lord Nelson* from the yard of Palmer's Shipbuilding Co., at Jarrow, on Sept. 4, was remarkable for the fact that she is the last battleship for the British Navy remaining on the stocks, either in the Royal or private yards. Her sister ship, the *Agamemnon*, was launched from Messrs. Beardmore's yard on the Clyde a couple of months ago, and these two vessels mark an intermediate stage between the *Dreadnought* and the *King Edward*. The *Lord Nelson* and the *Agamemnon* have four 12-inch guns and ten 9.2-inch guns, whereas the *Dreadnought* will carry ten 12-inch guns. In addition, they will be armed with thirteen 12-pounder quickfirers, twenty 3-pounders, two maxims, and five submerged torpedo-tubes. Their displacement will be 16,500 tons, and their engines will develop 16,750 I. H. P., which it is anticipated will give a speed of 18 knots, one knot slower than the *Dreadnought*. As to protection, they carry a water-line belt of 12 inches in thickness amidships, reduced towards the stern to 4 inches and 6 inches in the bows. In the central part of the ships, above the water-line, 8-inch armor protects the upper deck, and the protection athwartship against raking fire from ahead or astern is 12 inches in thickness, the conning-tower protection being the same. The principal dimensions of the vessels are: Length, 410 feet; beam, 79 feet 6 inches; mean draft, 27 feet. The first *Nelson* built for the navy (the name was without the prefix) was built at Woolwich, in 1814, and was the largest wooden line-of-battleship ever built in this country. Her overall length was 244 feet, and her length on the gun deck, 205 feet. Her extreme beam was 54 feet 6 inches, and she drew 24 feet forward and 25 feet aft, on a measurement of 2617 tons. Her depth to the upper part of the taffrail was 65 feet, and her armament consisted of 112 carriage guns and 18 carronades. The figure-head was a bust of Nelson, supported by Fame and Britannia, and bore as a motto the Trafalgar signal. There have been two other Nelsons. One was lent to Melbourne for the defence of that colony in the seventies. The other, which was built in 1880, is a vessel of 7000 tons, and she was the first flagship of the late Admiral Sir George Tryon on the Australian Station. She is now at Portsmouth, engaged in the training of stokers.—*Nautical Gazette.*

COASTAL DESTROYERS.—The first of the five new coastal destroyers built by Messrs. J. I. Thornycroft & Co., Limited, at their works at Chiswick, has recently been tried. This vessel—H. M. S. *Gadfly*—is small for a destroyer, being even less than the *Daring*, although somewhat larger than the last torpedo-boats. She is 168 feet long over all by 17 feet 6 inches beam, and draws, when laden, about 6 feet 6 inches. The propelling machinery consists of Parsons steam turbines, steam being generated in Thornycroft boilers burning oil fuel. It is evident we have here a very interesting vessel, and one whose trials should be capable of throwing valuable light on the most modern problems of marine propulsion. Unfortunately for naval architects and marine engineers at large, the Admiralty have determined to keep the whole design and the performance of this class as secret as possible, and the builders being bound by a prom-

ise of secrecy, we are able to present our readers with no more than a few outline details of the *Gadfly* and her performance, pending the arrival of information from abroad.

The propelling effort is divided between three shafts, half the total power from the engines being transmitted through the center shaft, and one-quarter of the total through each one of the wing shafts. There are altogether four separate turbines, capable of working, however, in series. The machinery is arranged so as to give a good economy at cruising speeds, for which the arrangement is as follows: On the forward end of the central shaft there is what is known as the cruising turbine, into which steam is directly admitted from the boilers. From this turbine steam is exhausted into the turbine on the starboard shaft, which forms the first, or high-pressure, turbine, at full speed running, or, rather, at speeds over about 16 knots. From this second turbine in the series for cruising purposes the steam is carried right across to the turbine on the port shaft, which is the medium, or intermediate, pressure turbine of the higher speed working. From the latter turbine steam is carried to the low-pressure turbine, which is abaft the first-mentioned cruising turbine on the central shaft. From the low-pressure turbine the steam passes to the ordinary cylindrical condenser on the port side of the vessel. It will be seen, therefore, that each wing-shaft has its own turbine, and that there are two turbines placed tandemwise on the central shaft.

For full-speed running the cruising turbine is cut-out altogether, and being then connected with the condenser, the blades revolve *in vacuo*, and therefore do not waste power to any appreciable extent. The port turbine then becomes the first, or high-pressure element, the intermediate and low-pressure turbines coming into the series as before. For going astern there are reversing blades in the exhaust casing of the low-pressure turbine.

The manipulation of the engines is, of course, entirely by valves. At full power running the steam valves between the engines and boilers are open, as well as the valve on the high-pressure turbine; but the valves admitting steam to the cruising turbine and for reversing purposes are shut. To reduce speed to below 16 knots the valve admitting steam directly from the boilers to the high-pressure turbine is closed, two valves admitting steam to the cruising turbine are opened, whilst a self-closing valve on the high-pressure cylinder has to be opened to pass steam from the cruising casing to the high-pressure turbine. For going astern from full speed ahead it is necessary to shut off steam from the high-pressure turbine by one valve and to open a valve admitting steam from the boilers to the exhaust-casing of the low-pressure turbine. There is also an auxiliary exhaust-valve to close; this can be done from the platform by means of gearing. For greatest speed there is a by-pass valve by which steam is admitted from the boilers direct to the high-pressure turbine some distance down the casing, so that there is then a double admission.

The striking characteristic of the engine-room of this vessel is its roominess and comfort. The machinery is no lighter probably than that which would have been installed if reciprocating engines had been used, but the gain in comfort, safety, and simplicity is enormous. The engine-room equipment does not contain other novel features, unless it is that wet and dry-air pumps, made by Weir, are placed in the after part of the engine-room. The engines for the *Gadfly* were made by Messrs. Parsons, at their Wallsend works, but the sets for the other four boats are being constructed by Messrs. Thornycroft, at their Woolston works.

The boilers, as stated, are of the Thornycroft water-tube type, and are fired by oil fuel. The system is that which has been developed by the Admiralty, and certainly appears to work with great success. As our readers are aware, experiments have been carried on for a long time past by engineers belonging to the Service, and those who have been engaged in them are to be congratulated at having arrived at what seems to be a

fairly perfect result. We are, for reasons stated, unable to describe the process; but it may be said that the success reached has been due to careful improvement in detail rather than to any radical departure from precedent. The oil used is a thick treacly substance of the appearance of crude Texan oil. It is evidently thoroughly atomized as the boat runs—at any rate after the boilers are once warmed up—without smoke or smell, and the chimneys remain quite cool, or cool enough to preserve the paint. The furnaces of the boilers are only adapted for oil fuel, there being no provision for burning coal. Probably oil-burning adds somewhat to the weight of the boiler installation, though not much, as a certain amount of firebrick must be used, and this would outweigh the saving through absence of fire-bars.

There is, however, a very important saving in the adoption of oil fuel, as with turbine-engines—that is, in the *personnel*. It would, we believe, be quite possible, if necessary, to arrange the *Gadfly* so that she might be run single-handed. In place of having to shovel coal on to the furnace, to trim it on to the stokehold floor, and clean fires at intervals, the boiler attendant—"stoker" would be a misnomer—has nothing to do but manipulate his feed and burner-valves if required. The fire remains constant, and consequently the steam pressure varies through a very small range; so long, of course, as the demand for power is constant. Much the same kind of thing may be said of the turbine-engines. Those who can remember the early days of torpedo-boat trials, with a crowd of men with oil-feeders, squirts, mops, and even half-pint tins bombarding the engines with lubricant, can best appreciate the quiet orderliness of a turbine-driven boat. It may be safely said that had water-tube boilers, oil fuel, and turbines preceded coal and reciprocating engines, the old Admirals of the forties would not have raised such a pother about the introduction of steam into the navy.

The *Gadfly* made her full-speed official trial on September 27, off the mouth of the Thames, the vessel being complete, including armament; and having on board a weight of 24 tons, representing stores, ammunition, etc., besides oil fuel for the trial. The contract speed was 26 knots. The mean speed reached during the 8 hours' run was 27.336 knots, while the six runs on the measured mile gave 27.505 knots. The mean revolutions were 1204 per minute, the steam pressure being 215 pounds to the square inch. The oil consumed during the trial was 22.8 tons. The exact power developed by the engines is, of course, unknown, but judging by the performance of other vessels of a corresponding class, the consumption of oil would be about 1½ pound per indicated horsepower per hour, or probably 1 pound less than the weight of coal that would be required. It is characteristic of turbine engines and oil fuel that the speed increased while the trial progressed, as fires did not get foul, and the "human factor" did not deteriorate through hard work and anxiety. It was considered that the only absolute limit to the duration of the trial was the amount of fuel carried. This would have given about 400 nautical miles at full speed.

On the following day (September 28) the maneuvering trials were gone through successfully. Going astern the boat was run for a quarter of an hour with the center propeller revolving at two-thirds the revolutions needed for 26 knots, the speed, as taken on the mile, being 12 knots. Afterwards the vessel was run astern at 699 revolutions per minute for a quarter of an hour, the speed being approximately 13 knots. Of course, only the center propeller was used on both these runs, the astern turbine, as stated, being only on the center shaft. Good results were also obtained in stopping and starting, these being pronounced equal to the performance of ordinary boats of the type.

The official 24 hours' low-power consumption trial, with the cruising turbine in use, was carried out in the Thames estuary on Monday and Tuesday, October 1 and 2. The speed registered was 12.037 knots, with

a mean of 459.5 revolutions per minute. The steam pressure averaged 150 pounds, and the vacuum 28 inches. The oil consumed was 2130 gallons, or about 8.88 tons. The maximum radius of action, with all oil-tanks full, would be about 1300 nautical miles.

It will be seen that with the *Gadfly* a most successful result has been obtained. Both the Admiralty officials, who have so successfully worked out the oil-fuel problem, and Messrs. Thornycroft, the contractors, are to be congratulated on the results. The only pity is that oil fuel is not as plentiful as coal.—*Engineering.*

The *Glow-Worm*, the second to be completed of five coastal destroyers ordered from Messrs. John I. Thornycroft & Co., Ltd., by the Admiralty, in connection with last year's naval program, was successfully launched, with all machinery on board, from the company's Chiswick works. The dimensions of the class to which the *Glow-Worm* belongs are: Length, 168 feet; beam, 17 feet 6 inches; draft, 5 feet, 11 inches, and the contract speed is 26 knots. The vessel is fitted with turbine machinery of Parsons type, built by Messrs. Thornycroft at Southampton, and Thornycroft water-tube boilers, while the armament will consist of two 12-pounder quick-firing guns and three torpedo tubes.

The new coastal destroyer, *Cricket*, built by Messrs. White, of Cowes, has just completed her contractors' trials with satisfactory results, and she will shortly be handed over to the government. In a recent 24 hours' continuous steam trial the vessel accomplished 1450 sea miles on her total oil stowage of 41 tons, and in an eight hours' test she developed a speed of over 27 knots, steadily maintaining her contract speed of 26.2 knots.—*United Service Gazette.*

The coastal torpedo-boat destroyer *Firefly*, was successfully launched from the works of Messrs. J. Samuel White & Co., Ltd., East Cowes. She is a sister vessel to H. M. ships *Cricket* and *Dragonfly*, and is the third vessel of her class to take the water of the five coastal destroyers building by this firm for the government under the 1905-06 naval program. The vessel is 175 feet long and of 230 tons displacement, her I. H. P. being 3600, and her speed 26 knots. The machinery consists of water-tube boilers, White-Forster patent (fired with oil fuel), and turbines, and manufactured by Messrs. White under Parsons patent.—*Page's Weekly.*

DOCKYARD AND CONTRACT BUILT SHIPS.—The Admiralty state that the figures of comparative cost of hulls in the case of similiar ships built in the Royal dockyards and private yards respectively, since the system of allowing contractors to complete vessels for service came into operation, are as follows:

	Cost of Hull.	
Battleships:	Contract built.	Dockyard built.
King Edward VII Class.		
Commonwealth	£918,517	.....
Dominion	884,435	.....
Hindustan	899,607	.....
King Edward VII	.....	£905,741
New Zealand	.....	872,560
Armored Cruisers:		
Monmouth Class.		
Berwick	400,354	.....
Cumberland	410,105	.....
Donegal	409,526	.....
Lancaster	424,594	.....
Kent	.....	420,667
Suffolk	.....	393,482
Essex	.....	445,094
Cornwall	.....	419,053

Devonshire Class.	Cost of Hull. Contract built.	Dockyard built.
Devonshire	.....	450,851
Antrim	501,506	.....
Argyll	511,164	.....
Carnarvon	492,292	.....
Hampshire	490,472	.....
Roxburgh	481,063	.....

—*Engineering.*

Several innovations have been made in the machinery department and general fittings of the British battleship *Hibernia*. The most important of these is the application of forced lubrication in the engine room. Weir's pumps have been fitted to the central bulkhead to force the lubricating oil by means of pipes to all parts of the bearings and cranks. For this purpose the crank pins have been perforated and grooves cut in the bearings. They are also all covered over to exclude all foreign matter. Another departure is in the method of heating the various compartments of the ship and the cabins by the substitution of hot air pipes for the steam pipes. The reservoirs are so designed that the hot air service may be disconnected from each such apartment at will. Another novelty consists in the application of motors for working the pumps. This practically completes the placing of all work which was formerly performed by manual labor under the domain of machinery and the engineer.—*Iron Age.*

SPEED TRIAL.—The last speed trial—eight hours' full power—of the Second Cruiser Squadron produced no record speeds, but was remarkable for the fine performance of the *Cornwall*, which has long been striving for the record, and has now pulled it off, beating the *Drake*. The results were:

	Average Speed. Knots.
23-knot Cornwall	23.8
23-knot Drake	23.2
22.3-knot Duke of Edinburgh	22-12
22.3-knot Black Prince	20.5
23-knot Berwick	(broke down)

There was a heavy head sea.—*Engineer.*

NEW SUBMARINES.—Considerable interest is centered on the new class of submarines, known officially as *C*, the first of which, *C1*, will be delivered from the builders, Messrs. Vickers, Sons & Maxim, at the beginning of next month. A crew for this vessel has been told off and is now at Barrow being instructed in the working of the new type before it is taken over. The speed of the vessel is 14 knots on the surface, one knot faster than the *B* class, the immediate precursors of the *C's*. The speed of the *B* class has enabled them to deliver successful attacks upon large craft from unexpected positions, and has been of especially good service to them in facilitating retreat after the attack, therefore the extra knot of speed given to the *C* class should tend to make them even more efficient. The *C* boats are larger than those of the *B* class, and have two propellers, while another innovation is the addition of a second periscope, which it is hoped will render impossible any repetition of the *A1* disaster, when, it will be remembered, the submarine was run down by a liner, which the one periscope, with its range of vision of 60 degrees, was powerless to disclose.—*United Service Gazette.*

INCREASE OF MARINES.—At one time it was clearly the intention of the Admiralty to abolish the Royal Marines. But circumstances have led to a complete change of policy in this respect, and now, instead of disbandment, our amphibious army is to be augmented in strength. The causes

which have brought about this change of front have been the handing over of coast defences to the Admiralty, including the manning of port defences, and the decision to establish a co-ordination of duties between the sea and the land forces. The initial step in manning coastal-forts is about to be taken at Milford Haven, where the garrisons at present supplied by the army are to be replaced by small detachments of the Royal Marine Artillery, and a more important development is in prospective in a scheme which is now under consideration of garrisoning Gibraltar exclusively with Marines. The intention is, of course, that all naval base defences and all important harbor fortresses shall, in time, be held by the Royal Marine Artillery, which body is to be brought up to a strength of 3620 officers and men, while the Royal Marine Light Infantry are to be increased to a total of 13,875 officers and men, exclusive of bandsmen in both cases. There will be a general feeling of relief that this grand old historic corps has been spared from the destruction marked out for it, for no finer or more useful body of men are to be found wearing the King's uniform.—*United Service Gazette.*

ADMIRALTY ANNOUNCEMENTS.—The Admiralty, in a circular letter issued to the fleet, state that they have had under consideration the question of providing for the cost of hospitality, which, from time to time, it may be necessary to offer to ships or squadrons of foreign naval powers, in circumstances where the entertainments are invested with an international character, and go beyond the casual entertainment of foreign naval officers by the officers of His Majesty's ships. In the latter case hospitality is recognized as a reciprocal duty, but in the former their lordships desire that officers of His Majesty's fleet should not be called upon to contribute to the entertainments from their private sources. Foreign ships and squadrons are to be received in a manner befitting the national prestige, and in cases where it is proposed to give such entertainments, the commander-in-chief or senior naval officer is to submit a detailed estimate for their Lordships' approval.

The Admiralty announce, in a circular letter, that the Royal Standard, being the personal flag of the Sovereign, is, by His Majesty's command, not to be displayed in future on board His Majesty's ships or on official buildings, as has been hitherto customary, on His Majesty's birthday and other occasions, but is only to be hoisted on occasions when the Sovereign is actually present, or when any member of the Royal Family is representing the Sovereign for the time being. In such case members of the Royal Family may fly the Royal Standard for the time being, but on no other occasion. The Royal Standard is to be used for Her Majesty the Queen in the same manner as for the King. As the occasions for all Royal salutes are officially notified, it is considered that the use of the Royal Standard is unnecessary when Royal salutes are fired in the absence of the Sovereign.

We are informed by the Admiralty that the following communication has been made to the fleet:

The Board of Admiralty have decided on the following alterations in the distribution of naval strength:

1. A distinct fleet will be constituted from the ships in commission in reserve to be called the "home fleet" under the supreme command of a flag officer with the status of commander-in-chief and headquarters at Sheerness, but his functions will not interfere with those of the existing commander-in-chief at the Nore. This fleet will be in every respect organized with a view to enhancing its value as a fighting force, and battle practice and other fleet exercises not at present carried out by the reserve divisions will be introduced. The primary object aimed at will be seagoing efficiency, and for this purpose the cruises of the Home fleet will be made as frequent as practicable.

2. A sliding scale will be adopted in the strength of nucleus crews, so

that the vessels first required in war will have the largest complements; while the vessels in special reserve, instead of having no crews as at present, will have adequate complements of officers and men to keep the propelling machinery and armament efficient. The vessels now in "special reserve" will be gradually replaced by other ships as they cease to be effective units of the home fleet. The Board of Admiralty will determine the nature of this sliding scale of nucleus crews from time to time.

3. The distribution of ships between the present Channel, Mediterranean, Atlantic, and Reserve fleets will be altered, in order to permit of the strengthening of nucleus crews and the organization of a home fleet as above described. No ships will be paid off, no men will be sent to the barracks or to the instructional schools, and no alteration will be made in the proportion of officers and men serving afloat.

4. The Board of Admiralty have also decided that, where it will conduce to the fighting efficiency and convenience of the service, there will be an interchange of vessels between the home fleet on the one hand and the Channel, Atlantic, and Mediterranean fleets on the other. For instance, any vessel in the three last-named fleets requiring an extensive refit will be placed temporarily by a ship of the home fleet.

5. The cruisers of the home fleet will from time to time be combined for instructional and tactical exercises with the cruiser squadrons of the other fleets, and the Atlantic and Mediterranean fleets will be combined as usual for the same purpose.

The Board of Admiralty are satisfied that the constitution of a home fleet will increase the immediate striking strength of the navy, and that the more active training which the nucleus crews will receive under the new system will add to the sea experience of the fleet as a whole.

These changes will be gradually carried out in such a way as to obviate any dislocation of the various fleets and squadrons.—*United Service Gazette.*

Table of punishments inflicted in the British Navy during 1905:

	Petty Officers and Men.				
	Seamen Class.	Non-Seamen Class.	Boys.	Royal Marines Afloat.	General Total.
Dismissed with disgrace	3	..	1	1	5
Dismissed as objectionable	66	62	11	14	153
Corporal punishment with birch	..	..	110	..	110
Imprisonment	1,367	1,445	16	356	3,184
Disrating	589	290	..	72	951
Cells	3,664	3,692	12	1,221	8,589
Minor punishments	63,790	29,272	7,093	14,552	114,707
Total	69,479	34,761	7,243	16,216	127,699

—*Page's Weekly.*

Flogging and birching, though still in the list of punishments authorized by the Naval Discipline Act, have been suspended by Admiralty order, the former since August, 1881, and the latter since January 30 last. The King's Regulations authorize caning on the breech with the clothes on in the case of boys and buglers under 18, but by Admiralty orders dated March 2, 1906, this punishment is only to be inflicted under the actual order of the captain, and is not to be carried out in public.

ITALY.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Roma	12,625	Gov't Yard, Spezia.	Building.
Napoli	12,625	" " Naples.	Launched Sept. 10, 1904.
Vittorio Emanuele	12,625	" " Castellamare.	" October 1, 1904.
Regina Elena	12,625	" " Spezia.	" June 19, 1904.
Armored Cruisers.			
San Giorgio	10,000	Gov't Yard, Castellamare.	Building.
San Marco	10,000	" "	"
Pisa	10,000	.....	Projected.
Amalfi	10,000	.....	"

The *Moniteur de la Flotte* gives the following as the characteristics of the four armored cruisers, *San Giorgio, San Marco, Pisa* and *Amalfi;* Length between perpendiculars, 131 meters; total length, 138 meters; beam, 21 meters; mean draft, 7.15 meters; displacement, 9800 tons. Armament: 4 10-inch of 40 calibers; 8 7.5-inch of 45 calibers; 16 3-inch; 8 47-mm., and 3 torpedo tubes, of which 2 are under water. Armor: A complete water-line belt of thickness from 180 mm. to 50 mm.; redoubts and traverses of 180 mm. thickness; 10-inch turrets of 180 mm.; and 7.5-inch turrets of 160 mm. Horsepower, 18,000. Speed, 22.5 knots. Normal coal supply, 700 tons.

FIAT MOTOR BOATS.—We are informed that the Fiat Muggiano Company, of Spezia are constructing motor launches for the Italian Navy, for the use of admirals and captains of the fleet. These boats are 27 feet 10½ inches in length and of 7 feet 6½ inches breadth, and when fully loaded with ten people and 150 kilograms of fuel on board have a draft of 19 inches. The motor provided is a standard 16-24 horsepower Fiat motor, and is so arranged that the control of the motor and the steering of the boat can all be managed by one man. The hull is of light galvanized steel. The firm are also constructing submersible boats of the *Glauco* type, work on one of 200 tons displacement now being in hand.—*Engineering.*

The Midvale Steel Co. of Pennsylvania has obtained from the Italian Government an order for 2100 tons of armor plate, valued at $1,000,000, for an Italian man-of-war. The American company was in competition for the contract with five European firms, including the Krupps. Its tender was $180,000 less than that of the Italian Terni factory.

The successful Italian bid of the Midvale Co. is about $131 in excess of its bid of $345 a ton for Class A armor, under which it obtained half the contract for supplying the armor for the new United States battleships *South Carolina* and *Michigan.*

In the contest for supplying the armor for the American battleships the Midvale concern underbid the Carnegie and Bethlehem companies, from $70 to $95 a ton, but the latter companies made a successful fight against the entire contract going to the Midvale Co., and one-fourth of the contract was awarded to each on the condition that they meet the Midvale bid of $345 a ton.—*Nautical Gazette.*

JAPAN.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Satsuma	19,000	Yokosuka.	Launched Nov. 15, 1906.
Aki	19,000	Kure.	Building.
Armored Cruisers.			
Ikoma	13,000	Kure.	Launched April 9, 1906.
Tsukuba	13,000	"	" Dec. 26, 1905.
Ibuki	13,000	Yokosuka.	Building.
Kurama	13,000	"	"
Scouts.			
Tone	2,500	Sasebo	Building.
Yodo	2,500	"	"
Mogami	2,500	Nagasaki.	"

THE JAPANESE NAVAL PROGRAM.—In the program of the Naval Department of Japan for the current year, special importance is attached to naval education, thus proving again that the Japanese are always careful in laying the foundations of a policy before attempting to carry out its details. This accounts for the great success which has attended all their efforts. The Naval Staff College in Tokio and other institutions for naval education will be greatly extended. The Staff College formerly could only admit forty students; henceforth it will be made to take in 115 students. At the Gunnery School, Naval College and Marine Corps, 10-inch or 8-inch guns will be installed for training purposes. The educational expenses of the Navy Office are expected to amount to between two and three million yen. At the same time, the naval strength of Japan will be greatly increased during the course of the year. Two battleships—the Aki and Satsuma—and several other vessels of various sizes will be launched during the year, and their equipment will be completed during the course of next year. In addition, the following list of ships captured from the Russians, and all now under repair, will show the magnitude of the new strength to be added to the Japanese Navy.

Class.	Name.	Tons.	Place of Repairing.
Battleship	Sagami (Peresviet)	12,674	Yokosuka.
"	Suwo (Pobieda)	12,674	"
Cruiser	Soya (Variag)	6,500	"
Destroyer	Yamahiko (Rieshiteini)	240	"
"	Satsuki (Biedovi)	350	Uraga.
Battleship	Iwami (Orel)	13,516	Kure.
"	Hizeu (Retvisan)	12,902	Sasebo.
Cruiser	Tsuga u (Pallada)	6,731	"
Destroyer	Fumizuki (Silni)	240	Takeshiki.
Gunboat	Shikinami (Gaidamak)	400	"
"	Makikumo (Posadnik)	400	"
Battleship	Tango (Poltava)	10,960	Maizuru.
Armoured cruiser	Aso (Bayan)	7,726	"
Armoured coast-defence ship	Mishma (Admiral Seniavin)	4,960	"
Cruiser	Novik	3,080	Hakodate.

The battleship *Iki* (*Imperator Nicolai I*, 9594 tons) and the armored coast-defence ship *Okinoshima* (*General-Admiral Appraxine*, 4126 tons) have already been repaired and are on duty in the navy. In order to meet the increased demands upon them, considerable additions and developments will be made in the dockyards and arsenals at Yokosuka, Takeshiki, and other naval stations.—*Engineering.*

The Japanese *Naval Budget* for the present year showed an increase of about four million yen upon that of 1905, and reached a total of 39,523,127 yen. There were some increases for shipbuilding on the extraordinary estimates, but the previous year had already borne some charges for the new program, of which we have given full particulars. The arsenal at Kure is to be enlarged, and a good deal is to be done to improve the port.—*Army and Navy Gazette.*

The battleship *Mikasa* has been raised, after many difficulties and doubt, to the great satisfaction of the nation. The Russian cruiser *Novik* has been raised in the neighborhood of Sakholm, and the mining vessel *Amour* at Port Arthur, the latter having received the name of *Amakusa.*

Nothing seems even now to be known as to the cause of the fire that led to the sinking of the *Mikasa.* She sank on September 11, 1905, and the first attempt to raise her was made on December 25 of the same year. It failed. Then followed a second attempt on January 16. This, too, was unsuccessful. The third essay was on June 23, but it was of the nature of an experiment, which enabled the authorities to stop some large rents in the side of the ship, which made the final effort, on August 7, successful. *Engineering* says the principal damage in the ship consists of a rip 81 feet long in the stern, and there were in all ten large holes in her sides. All the ammunition in her magazine and a torpedo seem to have exploded on the occasion of the fire, and of course this caused great damage. Four powerful 27-inch pumps, each capable of discharging 3000 tons per hour, were used in the operations. Congratulations were sent to Vice-Admiral Saito, Minister of the Navy, from many important personages, among others by Vice-Admiral Sir Arthur Moore, in command of the British squadron in the eastern seas.—*Army and Navy Gazette.*

The *Mikasa* and her adventures should make the Vickers-Maxim firm feel proud. She sank in mud, and remained there eleven months. Unlike the Russian ships at Port Arthur, she was not nicely greased below, but went down quite unexpectedly. When she was raised steam was got up in the forward group of boilers, and at 150 pounds supplied to the engines. Under her own steam she then moved away from the scene of her loss. There must be some uncommonly excellent work inside the *Mikasa,* and some very considerable smartness on the part of the Japanese salvers for them to be able to attempt to get up steam in a ship that had been so long below. That it was carried out without difficulty is, if possible, more wonderful still. There cannot be anything in connection with salvage that the West can teach Japan.—*Engineer.*

It is officially announced by the Japanese Admiralty that inquiry into the causes of the sinking of the *Mikasa* at Sasebo have shown that the disaster was owing to spontaneous explosion due to chemical decomposition. Thus the *personnel* of the Japanese navy are exculpated from all blame.

The *Moniteur de la Flotte* states that the *Aki* and *Satsuma* are to be armed with 4 12-inch and 12 10-inch guns, all in double turrets; 12 4.7-inch in a central battery; and 4 under-water torpedo tubes. They are to have turbine machinery of 27,000 horsepower, giving an estimated speed of 20 knots. The boilers are of Migabara type, with small tubes. Both ships are to carry torpedo defence nets.

It is reported upon good authority that one of the new Japanese battleships (*Aki*) and one of the armored cruisers are to be fitted with Curtis turbines, which are now being built in the United States by the Fore River Shipbuilding Co.

OIL FUEL FOR JAPANESE STEAMERS.—Consul C. B. Harris, of Nagasaki, referring to his previous report that Nagasaki shipyards had contracted to build for the Toyo Kisen Kaisha (Eastern Steamship Co.), of Tokio, for use on their Hongkong-San Francisco line two sister ships, each of 13,000 tons gross, now adds that the vessels are to be fitted to use oil for fuel. He is also informed that the steamship company's three vessels, the *America Maru, Nippon Maru,* and *Hongkong Maru,* each of 6000 gross tonnage, now plying between the ports named, will be refitted to burn the same fuel.—*Nautical Gazette.*

PERU.

One of the Peruvian cruisers building or completing at Barrow was launched there on September 24, and received the name of *Coronal Bolognesi.* She is a sister ship of the *Almirante Grau,* which has just had a very successful trial. Both vessels are of the scout class, displacing 3200 tons, and the contract for a full-power speed was 24 knots. The *Grau* attained 24.64 knots on the measured mile in the Clyde, and the performance of the machinery gave entire satisfaction to Admiral Carvajal, chief of the Peruvian Naval Committee on board. A trial of 24 hours was run to determine the speed and coal consumption at lower powers, all being satisfactory, and it was found that the vessel could steam at 22 knots as long as the coal lasted, with only eight of the ten water-tube boilers in use. The turning trials were also successful, and an opportunity was given for testing the system of wireless telegraphy with which the cruiser is fitted, the messages being received over a distance of 150 miles. The machinery on board was intended to develop 14,000 I. H. P., and is of the four-cylinder triple-expansion type. These cruisers have two 6-inch quick-firers protected by armored shields, firing severally fore and aft, with a wide arc of training, while the secondary armament includes eight 14-pound and eight 1¼-pound. There are also two submerged torpedo tubes. The Peruvian Navy is being partly resuscitated, a floating dock is being constructed, the coast is to be better lighted, and hydrographic work is in progress. Admiral Carvajal expresses great indebtedness to the Vickers Company for agreeing to all his requirements, and for making the greatest efforts to attain the best results.—*Army and Navy Gazette.*

RUSSIA.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Emperor Paul I.....	16,900	St. Petersburg (Baltic Yard).	Building.
Andrei Pervozvannui.....	16,900	St. Petersburg (Galerney Island).	Launched Oct. 20, 1905.
Evstafi.....	12,500	Nicolaiev.	Building.
Ivan Zlatoust.....	12,500	Sevastopol.	Launched May 13, 1906.
Armored Cruisers.			
Admiral Makaroff.....	7,200	La Seyne.	Launched May 8, 1906.
Bayan.....	7,200	St. Petersburg	Building.
Pallada.....	7,200	"	Launched Nov. 10, 1906.
Rurik.....	15,000	Vickers	" Nov. 17, 1906.
Protected Cruisers.			
Kagul.....	6,750	Nicolaiev.	Building.

No surprise can be felt that information concerning the Russian Navy is scanty. It has been stated that a new program of naval construction would shortly be put forward, but there is as yet no sign of it, although a new committee under the presidency of Lieut.-General Ratnik, who is an

inspector of naval construction, has been appointed to consider the matter. The *Marine Rundschau* says that the proposed battleship type of 19,800 tons has not been approved. Vice-Adimral Skrydloff succeeded the late Vice-Admiral Tschuknine in command of the Black Sea fleet, the ships of which—*Rostislav, Tri Sviatitelia,* and *Dvenadzat Apostoloff*—engaged in maneuvers or exercises in June. In the Baltic the torpedo flotillas have been watching the Finnish harbors and inlets in order to prevent the landing of arms and ammunition. For the same purpose a considerable number of torpedo-boats have been placed on Lake Ladoga. By a recent imperial order the ships were to make an evolution of coaling with the purpose of accomplishing this much more rapidly. The whole of the ship's company was to be employed, the time being taken, and the end of the coaling was to be signalled. On the following day the ships were to be washed down, and on the result of the evolution a report was to be sent to the Minister of Marine. All this is new in the Russian Navy.—*Army and Navy Gazette.*

The Russian battleship *Andrei Pervozvannui* was launched without ceremony at St. Petersburg on October 20. She was laid down in 1903, and is not expected to be completed until 1909, the length of time occupied in the work of construction having been extended by the recent troubles. An attempt is being made to embody in the ship some essentials proved to be required by the war, but she cannot be equal to the latest types, and will be much out-distanced by the time she is ready for sea. Her armament will comprise four 12-inch and eight 8-inch guns, all in turrets. There will be a complete armor belt, and an armored deck reinforcing the sides. The displacement is said to be 17,400 tons. Engines of 17,600 H. P., supplied by 25 Belleville boilers are to give a speed of 18 knots. Rumors are current as to the announcement of a new scheme of naval construction being forthcoming, and according to some versions the total outlay will this year be raised from £5,000,000 to £11,000,000, the additional money, it is surmised, coming from the Privy purse.—*Army and Navy Gazette.*

The new cruiser *Pallada* of 7900 tons and designed to have a speed of 23 knots was launched at the new Admiralty works at St. Petersburg on November 10. She is of the type of the armored cruiser *Bayan,* now in course of construction here.

The *Pallada* and the *Bayan* are to have 16,500 indicated horsepower, 6-inch armor belts of from 4 to 6¾ inches of Krupp steel, and will mount two 8-inch guns, eight 6-inch guns, twenty 12-pounders and four 6-pounders.

The new *Pallada* and *Bayan* take the place of the Russian protected cruisers of the same names sunk at Port Arthur, and refloated by the Japanese.—*New York Sun.*

The Russian cruiser *Rurik* was launched November 17 at the yards of Vickers, Sons & Maxim, Barrow-in-Furness. Her displacement is 15,000 tons. She is to make 21 knots with 75 per cent of her boilers working. Her armament is to be more powerful than that of any existing cruiser. It will consist of four 10-inch breechloaders, eight 8-inch guns, twenty 4.7-inch, twelve small quick-firers, and two submerged torpedo tubes.

The latest *Rurik* in the Russian Navy, before the one launched November 17, was one of the *Vladivostok* squadron which gave the Japanese considerable uneasiness during the late war, until Admiral Kamimura encountered it off Tsu Island on the morning of August 14, 1904. The fight lasted five hours, but at the end of it the *Rurik* had been sunk and the other two ships of the squadron, the *Gromoboi* and *Rossia,* were making their way to Vladivostok, badly damaged.—*New York Sun.*

Le Yacht states that two armored cruisers of 20,000 tons displacement are soon to be laid down in Russian shipyards.

SPAIN.

The Spanish naval authorities, actively supported by King Alfonso, are proceeding vigorously with the re-building of Spain's Navy. A considerable part of the construction program, involving an expenditure of £15,840,000, is already under way. There are to be eight battleships of 14,000 tons, and nine cruisers. Of the cruisers, four are already in being, the *Emperador Carlos V, Cardinal Cisneros, Cataluna,* and *Princessa de Asturias,* and other vessels are well advanced. The utmost efforts are being made to make Spain's new ships up to date in every way. The system of electrical power doors adopted by the Spanish Navy is the same as that in use on nearly all the new vessels of the United States Navy. It enables closure of the main bulkhead doors to be effected from an electrical central station located on the bridge.—*Page's Weekly.*

UNITED STATES.

VESSELS BUILDING.

No.	Name.	Speed. Knots.	Where Building.	Per cent completion Dec. 1, 1906.
	Battleships.			
14	Nebraska	19	Moran Bros. Co.	97.5
20	Vermont	18	Fore River Shipbl'g Co.	96.0
21	Kansas	18	New York S. B. Co.	95.2
22	Minnesota	18	Newport News.	98.0
23	Mississippi	17	Wm. Cramp & Sons.	69.6
24	Idaho	17	Wm. Cramp & Sons.	65.2
25	New Hampshire	18	New York Shipbl'g Co.	57.0
26	South Carolina	..	Wm. Cramp & Sons.	3.1
27	Michigan	..	New York Shipbl'g Co.	1.5
	Armored Cruisers.			
8	California	22	Union Iron Works.	97.0
9	South Dakota	22	Union Iron Works.	93.5
12	North Carolina	22	Newport News.	66.4
13	Montana	22	Newport News.	60.6
	Scout Cruisers.			
	Chester		Bath Iron Works	54.8
	Birmingham		Fore River Shipbl'g Co.	53.7
	Salem		Fore River Shipb'g Co.	54.0

LAUNCH OF THE NORTH CAROLINA.—The armored cruiser *North Carolina* was launched at the yards of the Newport News Shipbuilding & Dry Dock Co. on October 6. She is a sister ship to the *Montana* now building at the same yard. A contract for the construction of these vessels was entered into with the Newport News Shipbuilding & Dry Dock Co. on January 3, 1905, both to be completed in 36 months from date of contract.

The plans called for vessels of the following dimensions and characteristics:

Length on water-line, 502 feet; length over all, 504 feet 5½ inches, breadth (extreme), 72 feet 10½ inches, depth amidships (moulded), 42 feet 2⅜ inches; draft, full load (mean), 27 feet ½ inch; displacement (fully loaded), 15,980.86 tons; displacement on trial, 14,500 tons; draft on trial, 25 feet; total coal capacity, 2000 tons; coal on trial, 900 tons; maximum speed (average of four hours' run), 22 knots; maximum indicated horsepower, main engines (estimated), 23,000.

Armament—Main battery: Four 10-inch breech loading rifles, sixteen 6-inch breechloading rifles and four 21-inch submerged torpedo tubes. Secondary battery: Twenty-two 3-inch rapid-fire guns; twelve 3-pounder

semi-automatic rapid-fire guns; two 30-caliber automatic guns and two 3-inch field guns.

The hull is of steel throughout. It is protected by a water-line belt of armor about 17 feet 3 inches in height amidships, extending from the protective deck to the gun deck port sills, being stepped down at the ends; of a uniform thickness of 5 inches throughout the machinery and magazine space and 3 inches forward and abaft this. The upper side armor is disposed in the wake of the 6-inch battery and is 5 inches thick throughout. Nickel steel, 2 inches thick is disposed in wake of the 3-inch battery. Athwartship armor of 6-inch uniform thickness is fitted from the protective to the main deck.

The 10-inch barbettes extend from the protective deck to about 5 feet above the main deck and consist of 8-inch armor in front and 4-inch at the rear below and 6-inch armor above the gun deck. The 10-inch turrets have front plates 9 inches thick, rear plates 5 inches thick, side plates 7 inches thick and top plates 2½ inches thick. The conning-tower is 9 inches thick and has a door 6 inches thick; signal-tower, 5 inches thick. An armored tube, 30 inches in diameter extends from the base of the conning-tower to the protective deck.

Magazines and shell rooms are so arranged that about one-half the total supply of ammunition is carried at each end of the ship. The ammunition for 6-inch and smaller guns is conveyed by electric hoists directly from the ammunition rooms or ammunition passages to the decks on which it is required. The turret guns have separate turret ammunition hoists, operated by electric power.—*Nautical Gazette.*

Le Yacht, after discussing at some length the steam trials of the *Virginia* and *Rhode Island*, concludes that the results as regards coal consumption were very bad. This is attributed partly to the excessive combustion of the multi-tubular boilers, as much as 229 kilos per square meter of grate surface having been burned when 175 kilos should be the maximum for this type of boiler. In part it is said to be due to the fact that more power had to be developed to give the required speed of 19 knots than was anticipated—instead of 19,000 H. P. 20,524 was required for the *Rhode Island* and 23,105 for the *Virginia*. The fact that the *Virginia* took 2580 H. P. more than the *Rhode Island* for the same speed is attributed to the insufficient propulsive surface of the *Virginia's* screws, which with less diameter than those of the *Rhode Island*, have the same pitch.

ORDNANCE AND GUNNERY. TORPEDOES.

ABSTRACT OF ANNUAL REPORT OF NAVAL BUREAU OF ORDNANCE (1905-1906).—The rapid erosion of high-powered, large caliber guns has been only partially remedied, and they must soon be relined. A reserve of at least one-fourth of all calibers is to be provided. Improved gas-checks, gas-ejectors, and gas-ejector attachments for rammers are being experimented with. The maximum strain on mounts is to be reduced by a new recoil check. Designs have been completed for nearly all types of broadside mounts, and it is hoped to equip all the important vessels with these during the current fiscal year. The new model telescope for sights is a great improvement. All vessels are to be equipped with improved bore sights. The results of these improvements thus far is shown in improved target practice.

Money has been saved by the satisfactory employment of civilian inspectors. Progress has been made in securing smokeless powder of greater stability and ballistic efficiency, and an attempt is being made to get rid of the 3,500,000 pounds of brown prismatic powder so as to provide storage room for the new powder. No satisfactory shell of large caliber has yet been obtained. Base percussion fuses of marked superiority have been obtained.

There has been a material increase in the delivery of armor, though, owing to the sharp competition between shipbuilders, the complaints of delay in the receipt of armor continues. The output has reached its maximum, and all outstanding contracts should be completed within 14 months. Then the armor manufacturers will turn their energies in other directions.

The work of installing a well standardized system of battery control on all vessels will soon be completed. An attempt is being made to substitute telephones for voice tubes on board ship, but thus far without success.

The *Bureau* is about ready to proceed to manufacture satisfactory and efficient torpedoes on a large scale. Estimates are submitted for putting the new torpedo, which is equal in efficiency to any, on the *Maine, Missouri, Ohio,* and the sixteen torpedo-boat destroyers. War exercise tests of submarines are under way.

The report contains an account of the accidents to the 8-inch gun on the *Iowa,* and the 12-inch at the Proving Ground, and of the reorganization of the professional staff of the Bureau. The Bureau cannot too strongly record its appreciation of the loyal and capable support of the professional assistants. Their zeal and efficiency has made possible the successful administration of the affairs of the Bureau.

ANNUAL REPORT OF ARMY ORDNANCE BUREAU.—In the last annual report mention was made of an effort to improve the system of accounting in the Ordnance Department so as to determine more accurately the cost of the different articles manufactured by it, and it was stated that this cost would thereafter include, besides the indirect shop expenses, a proper percentage to cover the pay of the officers and enlisted men of the establishment, the general repairs and improvements to buildings, the clerical expenses, deterioration, and in general all those expenses which a private manufacturer must take into account, except profit. This percentage has been determined to be for the Frankford Arsenal 9, for the Springfield Armory 14, and for the Rock Island Arsenal 11.4. In comparing government manufacture with that at private establishments certain advantages characterize each method. The private manufacturer is not restricted to eight hours of labor per day; this may or may not be an advantage, but there is no doubt of the advantage resulting from his relief from the necessity of paying for 15 days of vacation per year, for seven national holidays and for Saturday half-holidays during the summer months. The time for which the Government in this manner pays, without return in labor, amounts to 10 per cent of the working time of the year.

On the other hand, the Government has a right to charge a less interest rate on the value of its plant, because its better credit enables it to borrow money at a less rate. Its losses by fire are also limited to those actually incurred, instead of being obliged to carry the "load" involved in the machinery of conducting insurance companies and the dividends to stockholders. Its high-class superintendence is also less liberally paid, and the deterioration of plant, like the insurance, is only that actually incurred, instead of being an amount which the manufacturer must often make large to cover himself against a lack of future orders, but which he rarely diminishes when the real cost of his plant has been actually covered. Added to all else is the profit, which the manufacturer will of course make as great as the conditions of industry allow. It is sometimes claimed that the private manufacturer has a stimulus spurring him to effort to reduce cost by improved methods and close supervision, which is lacking in a Government establishment. There is no necessity for the lack in Government establishments, if the career of the officers is made to be affected by their conduct of them, and there is the same possibility as in private establishments, of reward to employes for valuable suggestions. Success in diminishing private cost does not by any means signify lower prices to the Government, but rather greater profit to the manufacturer.

Below is compiled a statement showing the contract prices and the

arsenal cost of various manufactures of recent years. In some cases the contractors claim that their price was so low as to cause them a loss. The arsenal costs include all of the general percentages mentioned above. The evidence is in favor of Government manufacture, as will be seen from the following items:

3-inch field guns, model of 1902, contract price, $2499; arsenal cost, $2242.
3-inch field guns, model of 1905, contract price, $1990; arsenal cost, $1491.
3-inch field gun carriages, contract price, $3010; arsenal cost, $2292.
3-inch field caissons, contract price, $1522; arsenal cost, $1183.
15-pounder barbette carriages, contract price, $4042; arsenal cost, $3642.
15-pounder shrapnel, contract price, $3.96 each; arsenal cost, $2.83.
Ball cartridges for rifle, model of 1903, contract price, $42.50 per 1000; arsenal cost, $34.99 per 1000.

Last year's report referred to the effect of erosion in limiting the life of heavy guns, and to the possible necessity of finding some method of securing the necessary power less expensive than that involved in using the very high velocities of projectiles now employed, with the accompanying rapid wearing away of the rifling in such manner as to destroy the accuracy of the gun after a few rounds. Going into the subject in more detail and considering the 12-inch gun of the model of 1900 as an example, we have for the life of this gun, firing a projectile of 1000 pounds weight, with a velocity of about 2500 feet per second, only about 60 rounds. As the gun is capable of firing for a considerable interval at the rate of 45 rounds per hour, it is seen that the limit of its life could be reached in less than an hour and a half. It has been considered that in attempting to run by fortifications guarding the entrance of a harbor the period that would elapse from the time that the leading vessel of the fleet would come within range until the last vessel would pass beyond the range of the coast guns would be about two hours; it is therefore evident that a new 12-inch gun would not last through such an engagement. Similar statements can be made with regard to guns of smaller calibers, although as the caliber diminishes the admissible velocity increases. The 6-inch gun of the model of 1900, firing a projectile of 100 pounds weight with a velocity of 3000 feet per second, would have a life of 150 rounds, corresponding to about an hour and a quarter at the rate at which the gun can be fired. It needs only a statement of the situation to show the necessity for doing something to meet it, notwithstanding that the accuracy of the guns could be restored by relining them at much less than their original cost.

By lowering the velocity of the 12-inch projectile to 2250 feet per second the life of the gun is increased to 200 rounds, and by similarly lowering that of the 6-inch projectile to 2600 feet per second the life of the gun goes up to 450 rounds. The penetration of armor plate is, of course, reduced by this process, that of the 12-inch gun at 10,000 yards coming down from about 10½ inches to about 9 inches, and the range at which its projectile would penetrate 12 inches of armor plate being reduced from about 8000 yards to about 6000 yards, Krupp hard-faced armor being referred to in both cases.

To restore the offensive power the most obvious course is an increase of the caliber of the gun, and all considerations indicate that there is nothing against such a course and a great deal in its favor. A 16-inch gun has been successfully built and tested and there is no reason why this caliber should not be adopted for our guns of the highest power if it should be considered necessary. But let us examine an intermediate caliber. The design of a 14-inch gun has been laid down in this office, of which the weight is 49½ tons (111,000 pounds), the weight of the projectile is 1660 pounds, and such construction has been adopted as will involve a muzzle velocity of 2150 feet per second. The charge of powder required to produce this velocity is about 280 pounds, as against 366 pounds for the 12-inch gun of the model of 1900.

Summarizing the results of tests and manufacturing data, it appears that

by using in the situations requiring the greatest power a 14-inch gun with 2150 feet per second muzzle velocity of projectile instead of the 12-inch gun with 2500 feet per second initial velocity we would secure a lighter gun, a cheaper gun, a heavier projectile, greater muzzle energy, a still greater proportion of energy at each distance beyond the muzzle, and a life four times as long.

The Taft Board for the revision of the report of the Endicott Board on coast defence has recommended the use of the 14-inch gun in place of the 12-inch in situations where the highest power is required, and this department will hereafter construct guns of that caliber, abandoning as a maximum caliber the 12-inch, which had been tacitly adopted.

Congress at its last session made an appropriation of $165,000 for the establishment of an army smokeless powder factory. Steps are being taken for the selection of a proper site for the establishment of this factory, and when this site has been selected the work of erection of the factory will be pushed vigorously to completion. In the meantime plans and specifications for buildings and machinery are in preparation.—*Iron Age.*

NAVAL PRIZE-FIRING COMPETITIONS.—The shooting competitions in our Naval Service are becoming so popular among the officers and men of the fleet, and are so much responsible for creating the present burning zeal and boundless energy which permeates both the quarter-deck officer and the lower-deck man, that anything which tends to damp down this enthusiasm deserves to be met with the strongest possible opposition. On these grounds we wish to enter a strong and earnest protest against the advocacy of those who are striving so hard to abolish the gunlayers' test, now carried out in every ship in our fleet having a full complement of officers and men on board.

This year's competitions between the gunlayers and the guns' crews throughout the fleet were recently brought to a conclusion, and a portion of the ships have since carried out their battle practice. The competitions, so far as the results are at present known in what is essentially the men's competition, as no officers are allowed to have hand or part in it except to see the rules obeyed by the guns' crews, have been extraordinarily prolific of high individual scoring. This has especially been the case with the largest guns, such as the 9.2-inch and 12-inch weapons. The score of Petty Officer Sullivan, of the *Duke of Edinburgh*, mentioned in our columns last week, when ten hits were made with ten rounds in ninety seconds, from a 9.2-inch gun, on board that armored cruiser, while carrying out the gunlayers' test in Tetuan Bay, was a marvellous performance when measured by the old standards of the pre-*Scylla* and pre-*Terrible* days.

Yet in face of this high-class shooting, unquestionably brought about by the keenness created by a man-and-man competition, there are those who would deliberately remove this strong incentive to the straining of every nerve; those, who would, perhaps inadvertently, but nevertheless assuredly, damp down the tense and helpful spirit of rivalry now kept alive by a struggling for individual reward. It may be argued by those who would abolish the gunlayers' test, and thus quash the competition between the men, that this would enlarge the field by creating other competitions in which the officers and men might share alike in the honors and rewards.

If it was possible to establish so keen a competition at a longer range, and be, at the same time, able to pick out and adequately reward the *best* men—the central idea of all prize competitions, where individuals compete—then something might be said for the abolition side of the question. But we venture to think it is impossible to do so in any heavy-gun shooting in the navy, where the officers and men are engaged together, the former in "spotting" the fall of the shot and prompting, and the latter in rapidly loading and laying the gun for the object, and keeping the sights of the piece continually bearing on the object.

If praiseworthy shooting be made under these conditions of mutual help and mutual confidence, then the credit must be shared equally between those responsible for the performance. It would be impossible to select any single man of the crowd engaged and say this man did better than his neighbor in such a test of general skill and organization. Long-range firing usually means "salvo" or "broadside" discharges of groups or whole broadsides of guns, fired at the given signal of one man. The responsibility of giving the order, or doing the act at the right moment, rests in this case with one individual; but the laying of the separate guns belonging to the group belongs to the several men behind the telescope-sights of the different pieces of ordnance that go to make up the group.

If the guns are fired together with various degrees of accuracy, their shot pitch at various distances from the object aimed at. But who is to say whether the shot of this or that man is the nearest or farthest away? Or who shall say, if there be fault at all—or contrawise if there be credit—that it does not all lie with the man who gave the order to discharge the guns either too early or too late on the roll of the ship at the correct moment? Under such circumstances it should be perfectly obvious to the merest tyro in such matters, that it is next to impossible to reward individual merit or censure individual fault. And if there is to be no individualism, and no cutting and pruning among gunlayers, who like other mortals suffer physical decay and decline in professional skill, what means are we to adopt to replace the unfit by the fit?

Whenever bad scores were made there would be mutual charges and recriminations, often, perhaps, between officers and men, detrimental in the highest degree to discipline; whereas in the gunlayers' test, at present, each gunlayer fights for his own hand and reward, and a guns' crew have no one but themselves to blame if they fail to win a prize, taking their run of luck with the rest like good sportsmen. It is this personal touch and test that give the present zest to the competitions, and as the prizes are already far too small, it would be little less than suicidal to abolish them altogether, and trust to the honor of the bluejacket and Marine to make those personal sacrifices of individual training, and a period of tense effort necessary in strenuous competitions, which all other classes of the community are encouraged to undertake by the bait of either handsome money prizes, promotion, or high honor and decoration.

If good shooting is made at the gunlayers' test and bad shooting at battle practice, under normal conditions, then the fault is probably that of the "spotter" who directs the raising or lowering of the sights by which the guns should be well and truly laid. This probability arises from the fact that the same men, unaided by a "spotter" and shooting at a distance where they could see the holes their shot made in the target, or watch their shot falling short or over, by the telescope-sights, and thus do their own "spotting," have a few weeks previously shown themselves expert marksmen. In such a case the fault would generally rest with the officer "spotter." If on the contrary the men fire badly when working unaided, and do the same when prompted by a "spotter" at long distances, then the officer can scarcely be blamed if a bad gunlayers' test is followed by a bad battle practice performance. Whereas a good battle practice score, following on a bad gunlayers' test record, might fairly be credited very largely to the way the gunlayers had been guided to the target by the "spotting" officer aloft, and he would deserve, and probably obtain, their lordships' commendation.

The system at present in vogue meets these conditions, and has, so far as experience has gone, proved to be eminently satisfactory in developing our naval shooting, which is making rapid progress among guns of all calibers. To abolish the gunlayers' test, then, without the clearest ideas as to what is to be substituted to maintain the present gunnery keenness, and without being morally confident of a good result, would, in our opinion, be akin to midnight madness. And on the grounds mentioned above,

we strenuously oppose any such action being taken. Let the critics of the present system show us a better plan before the current one is tampered with. So far this has not been done.—*United Service Gazette.*

ELEVATING GEAR TESTS.—A number of qualified gunlayers of the United States Atlantic fleet have been at the proving grounds of the Bethlehem Steel Company, to try, in sub-caliber practice, some elevating gears for a 6-inch 45-caliber gun. Three speeds were supplied, which could be quickly changed, so that the men had an opportunity of seeing which suited them best for firing at the target, which had a motion similar to the apparent motion of a vessel's broadside from a rolling ship. These speeds gave 30, 50, and 75 minutes of angular motion to the gun's axis for one turn of the elevating wheel. There was also an arrangement whereby the man could use, as is customary, his left hand for elevating while firing with an ordinary electric trigger with his right hand on a stationary pistol grip, or could use both hands in elevating, in which case he fired by pressing with the forefinger of his right hand an electric trigger which was attached to the handle of the right hand elevating wheel and which, of course, was in continual motion. The target was 0.34 inches wide, which represents a free-board of 26 feet at a range of 6000 yards. Each man fired for five minutes at the target, which was caused to move vertically in an irregular and intermittent manner, simulating the rolling motion of a ship from one degree to eight degrees. The motion of the target was controlled and made correct by means of a series of curves, which caused its motion to be rapid at the middle of the roll and to slow off and stop at the top and bottom of the roll, as would be the case in a ship, and all rolls were described in fourteen seconds. That is, this was taken as the period of the firing ship for a complete double oscillation of whatever magnitude. This was arranged by means of a sound given every two seconds, which enable the man following the curves referred to to describe them at the correct speed and thus move the target at a correct speed. Owing to the fatigue caused by following with the gun this considerable rolling motion for five minutes, and to the better power to start and stop, and to the absence of a dead point, the double hand wheel gave better satisfaction than the single hand wheel. Also the speedier gears gave better results, especially on the high rolls. The system is analogous to that used in the British service.—*Army and Navy Gazette.*

The *Duke of Edinburgh* and *Black Prince*, of the Second Cruiser Squadron, have completed their gunlayers' tests at Gibraltar. With her 9.2-inch guns the *Duke of Edinburgh* fired ten rounds in 90 seconds, and secured 10 hits, her total record with this gun being 51 rounds and 44 hits, the number of hits per gun per minute averaging 3.67. With the 6-inch guns the record was 81 rounds and 71 hits; best gun, 9 rounds, 9 hits. The *Black Prince* with her 9.2-inch guns fired 32 rounds, making 21 hits, while with her 6-inch guns she scored 60 hits out of 71 rounds.

The *Exmouth*, flagship of Admiral Sir A. K. Wilson, V. C., commander-in-chief of the Channel fleet, has just completed her heavy gunlayers' test off Portland, with the following results: 12-inch guns: 19 rounds, 16 hits; 6-inch guns: 119 rounds, 86 hits. The *Exmouth* headed the returns in 1905, but this year the circumstances attending her firing have been far from conducive to good results. She commenced her test some months ago, but unfavorable weather, the salvage operations at Lundy, the grand maneuvers, and other circumstances intervened, and she has only just been able to complete her firing.—*United Service Gazette.*

PROGRESSIVE NAVAL GUNNERY.—The magnificent shooting performance by Petty Officer Sullivan, on board the armored cruiser *Duke of Edinburgh*, is an example of the wonderful progress that is being made all

along the line in naval gunnery. It is probably the best piece of shooting from heavy guns that the world has ever seen. To hit a target 21 feet by 17 feet 6 inches, at a range of 1600 yards, from a 9.2-inch gun, 10 times with 10 successive rounds, in the short period of 90 seconds, is a feat fully deserving the high praise that was bestowed upon it by that expert naval gunnery man, Prince Louis of Battenberg, who commands the Second Cruiser Squadron, to which the *Duke of Edinburgh* belongs. It must be remembered that this was an unaided effort on the part of the gunlayer and his crew, as the "spotter" officer is not allowed to prompt the men from aloft by indicating the fall of the shot to them, as is the case when battle practice is being carried out. In the gunlayers' test the man behind the telescope has to do his own spotting, and with the glasses now used he can at that distance see the holes in the target if the shots are hitting. This feat represents something more than just a specimen of accurate shooting from a large gun, beautifully mounted and splendidly poised; it is likewise a physical feat of the highest order, for the 9.2-inch gun is a hand-loading weapon, and has no hydraulic rammer to push home its charge and projectile. The breech arrangements are also worked by hand in a similar manner to the 7.5-inch, 6-inch, and smaller guns. The gun's crew, therefore, to have loaded a gun of this size 10 times in 90 seconds, must have been splendidly trained, and this is the part of the performance that has most struck the imagination of naval gunnery experts. With guns mounted and poised as our naval guns now are, good shooting is made easy to men with an aptitude for it, as the weapon can be made to follow the target horizontally and vertically, by elevation and training, with about the same facility as a fowler can make his piece, when raised to his shoulder, follow a bird. It is the loading of a gun and the supply of ammunition which form the chief difficulties. That these are being overcome the *Duke of Edinburgh*, the *Diana*, and *Prince George* have recently shown. The two latter ships have just obtained more than 50 per cent of hits at their long-distance practice. This is going ahead by leaps and bounds.—*United Service Gazette.*

FIRING EXPERIMENTS WITH THE MONTAGU.—The Ordnance Committee, acting in co-operation with the Director of Naval Ordnance and the Director of Artillery, have arranged to carry out some important experiments in firing at the battleship *Montagu*, stranded on Lundy Island, with the object of testing the effect of high explosives on modern armor.

The projectiles to be used are 12-inch and 9.2-inch armor-piercing shells with caps, having a bursting power of nominally 6 per cent in the case of the 12-inch shell, and of proportionate capacity in that of the 9.2-inch. The firing ship will be one of the *King Edward VII* class, which mount guns of these calibers, the vessel selected probably being the battleship *Africa*. Special charges will be used, and the firing ship will be moored. This will be the first opportunity that has presented itself of obtaining trustworthy information as to the effect of armor-piercing capped shell against modern armor in position, *en masse*, on a ship's side, and the results will be far more valuable than those gained by firing at single plates in proof cells at the various testing grounds. The experiments are also expected to have an important effect in demonstrating the damage caused by high explosives striking at an angle, this being rendered possible as the *Montagu* is partly heeled over. In this respect the conditions will therefore closely resemble those of a sea fight, and contribute to the meager information which the authorities possess of the effect of shell not striking with direct impact, but in a glancing position.

Another important feature of the experiments will be to show the efficiency of the fire control installation, as the positions where it is thought the control fittings would mostly be damaged by concussion, etc., are mostly available to be fired at in the *Montagu*.—*United Service Gazette.*

It is stated, and apparently on authority, that the factory at Chatham for the Brennan torpedo is to be converted to some other use. We regard the story as true because it seems to be only a logical sequence of the decision to place the defence of the harbors in naval hands. The Brennan torpedo has been a very expensive toy since the time when it was acquired by the War Office at a cost of £110,000, with a salary to Mr. Brennan, the superintendent of its manufacture. It has been the subject of much costly experiment, and installations of the machinery required for its manipulation are to be found at a few places at home and in our colonies and dependencies. But we have never yet heard that it was likely to give a satisfactory return for the outlay, or to exercise a deterrent effect, moral or otherwise, upon the action of an alert and enterprising enemy. It was purchased at a time when local and fixed defences were much more in favor than they are at present and it has never been regarded with a partial eye by the navy. Yet curiously enough it was a committee mainly of naval officers that first advised its being sent to this country for examination by the military authorities. It was then thought, however, that it might be utilized as a naval weapon, and it is because it labors under the disadvantage that it cannot be taken to the enemy that it has been held in such small esteem by seamen. Doubtless the factory can be used for other purposes than the manufacture of the torpedo, but we are assured that nobody will regret the disappearance of the Brennan from our national armory.—*Army and Navy Gazette.*

The *Moniteur de la Flotte* states that the Whitehead Co. has introduced a very important improvement in the depth regulator of the automobile torpedo. Nearly 100 pieces of the old mechanism are done away with, and the result is an increase of facility of regulation, a decrease of cost, and an increase of explosive charge. The 1906 model, now under trial at Fiume, is to give a range of from 1000 to 1500 meters at from 40 to 42 knots' speed.

In torpedo practice at Berehaven by the Channel fleet last week, the hits were 90 per cent, the only drawback to the operations being that four of the torpedoes were lost. The fleet was divided into two sub-divisions, one headed by the battleship *Exmouth* (flagship) and the other by the battleship *Albemarle*. They steamed in opposite directions at 2000 yards range, and the speed of each was unknown to the other. When abreast, torpedoes were discharged at the battleship occupying the corresponding position in the opposite line. The torpedoes, which were fitted with collision heads, were discharged with almost unerring precision, only two failing to find the mark.—*United Service Gazette.*

In the opinion of many experts, the hand-grenade or bomb will in future tend more and more to supplant the use of the bayonet for close-quarter fighting, and it will be remembered that grenades were most effectively used by the Japanese in the late war. A grenade for such purposes is made by the Cotton Powder Company, of 32 Queen Victoria street, E. C., and is 7 inches long by 1⅝ inch in diameter. This "Hale" hand-grenade can be thrown 30 or 40 yards by means of a tail rope 18 inches in length. The detonator is carried separately in a pouch, and only screwed into the grenade just before it is to be thrown. The weight is about 1 pound 4 ounces, and they may be carried on a belt with perfect safety to the soldier. The charge is of tonite, but any other high explosive may be employed with good effect.—*Engineering.*

MISCELLANEOUS.

RULES FOR WIRELESS TELEGRAPHY IN TIME OF WAR.—At the closing session of the Institute of International Law, held recently in Ghent, Belgium, the following articles relative to wireless telegraphy were voted:

The regulations governing wireless telegraphy in time of peace are ap-

plicable in principle in time of war. Belligerents may prevent the transmission of Hertzian waves by a neutral state over the high seas within the sphere of their military operations.

All persons taken prisoners while receiving or transmitting wireless messages from belligerent territory or between different sections of a belligerent army are not to be considered spies, but are to be treated as prisoners of war, unless their operations were carried on under false pretenses.

Carriers of dispatches received by wireless who make use of concealment or ruse in their work will be regarded as spies.

Neutral ships and balloons proved to have been used to furnish an adversary with information helpful in the conduct of hostilities may be removed from the zone of hostilities and the wireless apparatus on board seized and sequestrated.

A neutral state is not obliged to prevent the passage across its territory of Hertzian waves destined to a country at war. A neutral state has the right to close or take over the wireless telegraphy station of a belligerent operated in its territory. Every prohibition in the matter of wireless communication made by belligerents must at once be communicated to neutral governments.—*Electrical Review.*

MOTOR TORPEDO BOATS.—A line of investigation being pursued by the naval authorities which opens up a new avenue of construction, is in connection with the torpedo motor boat. The first boat of this class, that built by Messrs. Yarrow & Co., was described in this journal on its first appearance some months ago, and there is no doubt, as Sir William White has said, that the introduction of the internal combustion engine has given naval designers a new field in which to work. The tests made with this boat are understood to have been so satisfactory that it is now regarded as the first of a numerous flotilla designed for coast service, and its advantage on the score of efficiency and low cost are such as to undoubtedly recommend it to a government which has embarked on a policy of economy in regard to naval construction. The development of the petrol marine motor has made it possible to build 60-foot boats, capable of carrying two torpedoes and the necessary equipment and crew at a speed of 24 knots for a distance of 250 miles, a performance well ahead of what could be achieved with a steam engined boat of the same length. The new departure will be watched with interest.—*Page's Weekly.*

In an address at the Engineering and Machinery Exhibition at London on October 4, on "Large Gas Engines," H. A. Humphrey, M. Inst. C. E., said that under favorable working conditions a large gas engine develops a horsepower hour for 0.8 lb. of coal, while a steam engine takes about 2 lb. In Germany, with 24 makers in the field, competition has led to improvements in design. While German and Belgian firms have met heavy losses in their gas engine experiments, the possibilities of these engines have had better appreciation on the Continent, where coal is dearer. The speaker had information to the effect that the use of gas engines and electrical equipment of the rolling mills has reduced the price of finished products 13s. to 18s. a ton. While the list was not complete he had obtained particulars of 531 large gas engines, having a total of 544,240 hp. —*Iron Age.*

PANAMA CANAL PLANS.—The Isthmian Canal Commission has issued a statement describing the general plan for the construction of the Panama Canal. It is explained that the type of canal proposed by the minority of the Consulting Board is to form a summit level about 85 feet above the level of the sea, which is to be reached by a flight of locks built at Gatun, on the Atlantic side, by one lock at Pedro Miguel and two others at La Boca, on the Pacific side. The locks are all to be in duplicate.

The summit level will be formed by the construction of a large dam at Gatun and a small one at Pedro Miguel. A second lake, with a surface elevation of 55 feet, will be formed on the Pacific side between Pedro Miguel and Panama Bay by the construction of a dam at La Boca, across the mouth of the Rio Grande, and another dam between Sosa Hill and high ground near Corozal.

From the Caribbean Sea to the mouth of the Mindi river a channel is to be excavated, having a bottom width of 500 feet and a depth of 45 feet below mean tide. From the mouth of the Mindi to the Gatun locks the width and depth are to be the same as from the sea to the mouth of the river.

The Gatun locks are to be built in duplicate. The lift will be overcome by a flight of three locks of 28⅓ feet or by two locks of 42½ feet each. The Gatun dam will reach from a point near the Gatun Hills, on which the locks are to be located, to the hill 3500 feet westward, in which the spillway will be built. The object of this dam is to form a reservoir in which the floods of the Chagres will be received. Its area will be approximately 110 square miles. Works for regulating the level of the lake will be situated in the hills that lie midway between two extremes of the dam. They will consist of a system of gates constructed on foundations of concrete. The gates will be almost counterparts of those used on the Chicago drainage canal.

From the Gatun locks to San Pablo, a distance of about 15 miles, only a small amount of excavation will be required. The width of the canal will be about 1000 feet and the depth 45 feet. The growth for 50 feet along the shores is to be removed. Further up the lake, as the amount of excavation necessary to obtain a depth of 45 feet increases, the width of the channel will be decreased, first to 800 feet, then to 500, then to 300 from Obispo to Las Cascades, a distance of about 1½ miles, where the Culebra cut begins.

The channel from Matachin to Bas Obispo may be narrowed to 100 feet. From Las Cascades to Paraiso, a distance of 4.7 miles, the width of the channel will be 200 feet. This is the most difficult work of the whole canal construction. From Paraiso, the end of Culebra cut, to the Pedro Miguel lock, a distance less than two miles, the channel will be 300 feet wide. The Pedro Miguel lock will have a lift of 30 feet and will be in duplicate, with approach walls at each end. From the lock for a distance of 1.87 miles the channel will be 500 feet wide, and will then be increased to 1000 feet for a distance of 3.61 miles to Sosa Hill, on the shore of Panama Bay, where the Sosa locks will be built. These locks will be in two flights with lifts of 27½ feet each, and will be in duplicate.

A dam will be constructed across the Rio Grande from San Juan Hill to Sosa Hill, another from Sosa Hill to Corozal Hill and a small dam from Corozal Hill to the high ground eastward. These dams will form a lake known as Soso Lake. It will have an area of eight square miles and will be provided with regulation works for discharging the surplus water.

From the Sosa locks to deep water in Panama Bay, a distance of four miles, the channel is to have a bottom width of 500 feet and a depth of 50 feet below mean tide. The mean rise and fall of the tide is about 15 feet.

The Panama Railroad will be relocated throughout almost the entire distance from the mouth of the Mindi river to Panama, and some heavy embankments will be required to cross certain parts of Gatun Lake.—*Iron Age.*

COMPARISON OF A TURBINE AND A RECIPROCATING ENGINE FOR THE UNITED STATES NAVY.—Although we have been rather late in taking up the question of the marine turbine in this country, it is gratifying to know that the two most successful forms of the turbine, the Parsons and the Curtis, the

former a British, and the latter an American development, are now under construction for use in American-built vessels. Of the various marine turbine installations proposed or in course of construction, perhaps the most interesting is that which is being built by the Fore River Shipbuilding Company for the United States scout *Salem*. The *Salem* is one of three 24-knot ships which were authorized in 1904, and whose contract was signed in May of 1905. In designing these vessels, the government wisely determined to use the opportunity here afforded to test the relative efficiency of the turbine and the reciprocating engine in the propulsion of fast ships. The contract for the construction of two of the vessels, the *Birmingham* and the *Salem*, was awarded to the Fore River Shipbuilding Company, and the third vessel was given to the Bath Iron Works, Bath, Me. The two ships which are being built by the Fore River Company, the *Birmingham* and the *Salem*, will be equipped respectively with reciprocating engines and Curtis turbines, while the *Chester* will be driven by Parsons turbines. The engines of the *Birmingham* will be of the twin-screw vertical expansion type; those of the *Chester* will consist of four turbines, driving four propellers, while the *Salem* will be driven by twin-screw turbines.

These navy scouts will be 420 feet long, 47 feet 1 inch in beam, and the mean draft will be 16 feet 9 inches, on which draft they will displace 3750 tons, the full-load draft being 4687 tons. Each ship will be armed with twelve 3-inch rapid-fire guns and two of the new 21-inch turbine torpedo tubes. The contract calls for a speed of 24 knots with a development of 16,000 horsepower.

The following table is a comparison of one of the Curtis turbines built for the *Salem* and one of the triple-expansion engines built in the same shops for the battleship *Vermont*. The turbine is of 8000 brake horsepower and the reciprocating engine of 8250 horsepower. A comparison of the dimensions and weights of the two engines is greatly in favor of the rotary type.

TURBINE ENGINE.

Lenth over all	16 feet 2¾	inches.
Width over all	13 feet 6	inches.
Height over all	12 feet 6	inches.
Length over stuffing boxes	14 feet 5½	inches.
Length over all, shaft	23 feet 7	inches.
Size	120	inches.
7 stage, R. P. M.	350	
Weight	102	tons.

RECIPROCATING ENGINE.

Length over all	33 feet 6½	inches.
Width over all	11 feet 3	inches.
Height over all	21 feet 9	inches.
Length over all, cylinders	32 feet 9	inches.
Length over all, crankshaft	31 feet 1	inch.
R. P. M.	120	
Weight	153	tons.

The above shows that on practically every point of comparison recorded, the turbine has an advantage and particularly in the matter of length, height, and weight, being only half as long, not much over half as high, and only two-thirds as heavy. The tests on an experimental turbine, built expressly for testing this type of turbine, show that in steam consumption there is a proportionately fine economy.—*Scientific American.*

THE MINOR NAVIES OF THE WORLD.—There is, perhaps, no subject more discussed in the present day than that which has been denominated by the great American seaman-author, Captain Mahan, as sea-power. As steam-power has increased, and as year by year the steamship has grown in both size and swiftness, the nations have discovered that where in the old sailing days they were self-contained entities, producing for their own consumption those articles necessary for their existence, to-day a much wider application of the term "necessaries" has sprung into existence. Articles which but a couple of decades ago were the luxuries of the rich are now the common objects of the coster's barrow in the great capitals and wealthy cities of our complex civilization, and all this has meant an enormous increase in sea carriage among the nations, the erstwhile self-containedness of which has been exchanged for that inter-dependence and commercial cosmopolitanism which is the principal feature of the age in which we live. This world-wide commerce, and the different class of vessel which is now engaged in it, has altered many features in the sea routes of the world, of which one instance may suffice; ten or, at the most, fifteen years ago Gibraltar was a great port of call for all steamers bound outward "up the Straits," or homeward from the Mediterranean, for the purpose of re-bunkering, and where, in those not very far distant days, fifteen or twenty steamers would enter or leave the port daily, at present one or two have taken the place of the larger number, and those which now make regular calls are nearly all of the big liner class, who never coal in the bay. Nowadays the humblest tramp carries coal sufficient to take her from London or Liverpool to Port Said, and the once-flourishing coal trade is a thing of the past in Gibraltar. The day of the giant merchant-ship is also the day of the leviathan man-of-war; the tonnage and horsepower of the Great Eastern, so long the standard of all bigness, have now long since been surpassed, and concomitantly the size of warships has increased until, in the present, we are confronted with the accomplished fact of the *Dreadnought*, and the plans of France, Germany, Japan, and the United States to follow where England has led. Competition in trade in the twentieth century seems to be followed by further competition in armament as surely as the night follows the day; and the taxpayer, who gasped at the idea of a warship costing a million pounds sterling, has now to steady his nerves sufficiently to accept the fact that the powers that be now consider an expenditure of double that sum necessary on the vessel which is destined to guard his hearth and home. Building programs for navies have increased beyond the wildest dreams of even ten years ago, and we may note, without any intention of entering into any controversy on the subject, that it is Great Britain which has shown the first signs of weakening in that competition in which, whether she likes it or not, she is bound for the sake of her very national existence to remain at the head. The fact of this strenuous striving after an equality with our own country on the part of other Powers renders an examination into the force at the disposal of the minor navies of the world all the more interesting, as, in the event of some Titanic sea struggle happening, the possible exhaustion of the combatants might render the aid of those whom we regard at present with a certain measure of contempt an asset by no means to be despised. It is not really very difficult to separate the great from the small in the matter of sea-power, as the former category is really a small one, which comprises Great Britain, the United States of America, France, Japan, and Germany; Italy and Austria can be placed intermediately, and we then come to those nations which are not regarded as serious rivals by any of those just mentioned. Of Russia it is, of course, unnecessary to speak at present.

Those fine seamen, the Scandinavians, rightly come first in consideration of minor navies, and their requirements in the shape of men-of-war are rightly and sensibly limited to ships destined to defence. They have

at present no ship in commission larger than the *Äran* class, of which there are four; their displacement is 3650 tons; length, 287 feet; beam, 49¼ feet; maximum draft, 16 feet; these vessels carry two 8.2-inch 45-caliber and six 6-inch guns, ten 3-pounders, two 1-pounders, and two submerged torpedo-tubes. The *Distrigheten*, of 3500 tons, has a similar armament, except that she carries 6-pounders instead of 3-pounders; the *Svea* class, of three ships, are of 3300 tons, with an armament different from the others, in that they carry one 8.2-inch gun less, one more 6-inch gun, and one more 6-pounder. The *Odin*, *Thor*, and *Niord*, of 3400 tons, and which dates from 1879, 1898, and 1899, respectively, concludes the list of Swedish warships other than torpedo craft; their armament consists of two 10-inch and six 4.7-inch guns, ten 3-pounders and two 1-pounders, and one submerged torpedo-tube. A cruiser—the *Fylgia*, laid down in 1905, of 4060 tons—is building, as also a coast service battleship—*Oscar II*—of 4275 tons. The torpedo craft comprises five torpedo-gunboats, two destroyers, and some torpedo-boats.

The sister kingdom of Norway possesses two cruisers—the *Norge* and *Eidswold*—of 3800 tons; two—the *Harald Haarfagre*, and *Tordenskjold*—of 3400 tons; and three torpedo-gunboats. Norway and Sweden have need for navies owing to the propinquity of Russia and Germany; and although their force is small, it is said to be, as might be expected, extremely efficient; and in the stormy and foggy waters in which they are called upon to operate there is no doubt that these few Scandinavian vessels would prove a hard nut to crack.

Denmark possesses three coast-service battleships of the *Herluf Trolle* type, of 3470 tons, carrying three 9.4-inch and four 6-inch guns, ten 6-pounders, four 1-pounders, five machine-guns, and five torpedo-tubes: The *Skjold*, dating 1896, is 2160 tons; but the remaining craft, the *Valkyrien*, of 3020 tons, built in 1880; *Tordenskjold*, 2580 tons, 1880; *Iver Hitfeldt*, 3200 tons, 1886; and *Helgoland*, 5370 tons, 1878, may be dismissed as being absolutely without fighting value in the present day. There are no seamen in the world for whom the British have had a greater respect than for those of the Low Countries as Van Tromp, de Ruyter, and many a stout Dutchman besides caused us much trouble in the days of old; for was it not the Dutch who burnt British vessels in the Medway, and can we not to-day see the captured English flags hanging in the cathedral at Amsterdam? But the days when Holland could measure herself with England are gone, never to return; and the old amphibious breed, sheltering behind the dykes which keep out the German Ocean, are to-day possessed with a lively fear of a foe which may come from the south, and not from the north, a foe which desires, above all things, ships, colonies, and commerce, and which casts covetous eyes on the ports of Belgium and Holland. Maritime expansion on the large scale is not possible for either a mercantile or an imperial navy, and Rotterdam and Antwerp in German hands would make a nice commencement of that new state of affairs when Germany is to reign supreme from the North Sea to the Adriatic. But meanwhile Belgium is neutralized by European agreement, and the Dutch, as all the world knows, have before now preferred that the North Sea should swallow their territory sooner than that it should remain in the possession of any save themselves.

Meanwhille the navy of Queen Wilhelmina is no very formidable affair, as the largest battleship, the *Tromp*, is but of 5300 tons, carrying two 9.4-inch and four 6-inch guns, twelve 12-pounders and four 1-pounders and three torpedo-tubes. There are also the *Koningin Regentes*, *de Ruyter*, and *Hertog Hendrik*, of 4950 tons, carrying two 9.4-inch and four 6-inch guns; the *Evertzen*, *Piet Hein*, and *Kortenaar*, of 3520 tons, carrying three 8.2-inch and two 6-inch guns; the *Koningin Wilhelmina der Nederlanden*, of 4600 tons, with one 11-inch, one 8.2-inch, and two 6.8-inch guns; and besides the six cruisers of the *Holland* class, of 3950 tons,

carrying two 6-inch 40-caliber and six 4.7-inch guns. These, with some torpedo-boats, make up the naval strength of Holland.

Another old antagonist of the Dutchman—the Spaniard—comes next on the list; but since the war with the United States, in 1898, very little has been done in the Peninsula to remedy the state of weakness to which that conflict reduced her: the *Pelayo*, of 9950 tons, dates from 1887, and can accordingly be hardly considered seriously in the present day; the *Princesa de Asturias* and *Cataluna*, of 7000 tons, date respectively from 1896 and 1900, and carry two 9.4-inch and eight 5.5-inch guns; the *Emperador Carlos V*, of 9200 tons (1895), *Lepanto*, 4826 tons (1892), and four small cruisers complete the list of Spanish naval power.

Portugal possesses the *Vasco da Gama* (which dates from 1875, but was reconstructed at Leghorn in 1902), of 2500 tons; the *Dom Carlos I*, of 4100 tons, dating from 1898, carrying four 6-inch and eight 4.7-inch guns; the *Rainha Dona Amelia*, of 1665 tons; the *Adamastor*, of 1750 tons; and the *Sao Gabriel* and *Sao Rafael*, of 1800 tons. There are, in addition, a number of gunboats, of no value whatever.

The Turkish fleet may be mentioned *en passant*. But it is to be imagined that no one—least of all the Yildiz Kiosk—is likely to take this as a serious force; it can only be a matter for wonderment why persons so shrewd as the Sultan and his environment should ever have wasted money in the purchase of ships for the purpose of allowing them to slowly molder into decay at the Golden Horn.

The Greeks are the possessors of three battleships, of 5000 tons—the *Psara*, *Spetsai*, and *Hydra*. Roumania is credited with a cruiser—the *Elizabeth*, of 1320 tons; and Bulgaria with a torpedo gunboat, of 715 tons. Even an alliance comprising all these Powers would not materially alter the balance of power in Europe. This completes the tale of the ships belonging to the minor European Powers; but we have yet Asia and America with which to deal. In the former continent China possesses the *Hai-Chi*, of 4300 tons; the *Haiyung*, *Hai-Shew*, and *Hai-Shen*, each of 3000 tons; and some gunboats and torpedo craft. But China, although like Japan, she has had in her time the services of most able British naval officers to help to train her fleet, has not profited by the instruction given, and as soon as the Englishmen were withdrawn, the ships and crews were allowed to drift back into the state of hopeless incompetence which obtained before. Siam has one cruiser—the *Maha Chakrkri*—and a few gunboats.

And now in considering the minor navies of the world there remains America, in which continent there are a good many vessels of war apart from the fleet of the United States, which is projected to be, as all men know, only second in power and importance to that of Great Britain herself. If anything has been said concerning naval matters at the Pan-American Congress sitting at Buenos Ayres, nothing has transpired; but if there should have been an idea of adopting the proposition of Señor Drago, the Argentine representative, which amounted to no less than resistance to any forcible attempt on the part of Europe to collect debts justly due, the navies of the Central and South American Republics would have been hardly adequate to the demands upon them; but Mr. Root, the United States representative, could hardly be persuaded to see eye to eye with Argentina, and in consequence the project dropped. The idea of America, North and South, as a self-contained continent, brooking no interference from the nations of Europe, is, of course, no new thing, being neither more nor less than the Monroe doctrine, to which the ingenuous and ingenious Señor Drago would wish to add that other doctrine propounded by him; but Europe, which has accepted the *lex non scripta* of the United States, would certainly jib at any extension of the principle which might easily eventuate in complications of a most undesirable character. Although, taken singly and compared with European navies, America presents nothing very formidable from the point of view of armed

maritime force; still, if we collect together the warships of Argentina, Brazil, and Chili, we shall find that collectively they might prove a not unimportant addition to the strength of the United States in repelling any attempts to violate the hegemony which that Power has decreed shall exist on the western side of the Atlantic Ocean. Argentina possesses the *Independencia* and *Libertad*, of 2336 tons, carrying two 9.4-inch and four 4.7-inch guns; *Almirante Brown*, of 4627 tons, with ten 6-inch guns; *Pusyredon* and *General Belgrano*, of 7000 tons, with two 10-inch and ten 6-inch guns; the *Garibaldi* and *San Martin*, of similar armaments; the *Buenos Aires*, of 4500 tons, with two 8-inch and four 6-inch guns; *Nueve de Julio*, of 3500 tons, with four 6-inch and eight 4.7-inch guns; *Vinte-Cinco-de-Maio*, of 3200 tons, with two 8.2-inch and eight 4.7-inch guns, besides some old vessels and torpedo craft. The naval authorities of Argentina have under consideration designs and tenders from the leading shipbuilders for the construction of several large vessels, including battleships.

Brazil has the *Riachuelo*, of 5700 tons, but as her date is 1883, she can hardly be reckoned as an efficient warship; the *Deodoro* and *Floriano*, of 3162 tons, carrying two 9.2-inch and four 4.7-inch guns; *Barrozo*, 3450 tons, with six 6-inch and four 4.7-inch guns; *Tamandare*, of 4537 tons, with ten 6-inch and two 4.7-inch guns; also old vessels and torpedo craft. There was recently ordered by the Brazilian Admiralty three battleships, two of which are to be built by Sir W. G. Armstrong, Whitworth & Co., Limited, and one by Messrs. Vickers Sons & Maxim, Limited, who, we understand, will construct the propelling machinery for all three.

Chili has the *Captain Prat*, 6900 tons, with four 9.4-inch and eight 4.7-inch guns; *O'Higgins*, 8500 tons, with four 8-inch and ten 6-inch guns; *Esmeralda*, 7000 tons, with two 8-inch and sixteen 6-inch guns; *Blanco Encalada*, 4420 tons, with two 8-inch and ten 6-inch guns; *Chacabuco*, 4300 tons, with two 8-inch and ten 4.7-inch guns; *Ministro Zenteno*, 3600 tons, with eight 6-inch guns; also old ships and torpedo craft. Chili, like her neighbors, aims at the strengthening of her fleet, and, as in the case of Argentina, has plans and prices of ships before a naval commission; but the great financial loss due to the earthquake must intensify a situation not very encouraging, so that the government may be disposed to pause in the matter of naval expansion. Such a decision might influence Chili's great rivals of Argentina, inducing them also to defer, on new warships, the expenditure of capital which must be borrowed in any case.

Belgium, Cambodia, Columbia, Costa Rica, Ecuador, Egypt, Hayti, Morocco, Mexico, Persia, Peru, San Domingo, San Salvador, Sarawak, Uruguay, Venezuela, and Zanzibar are possessed of vessels of a nominally warlike character, which fly the flags belonging to these states, but none of which are of the smallest value. There are also a certain number of merchant vessels subsidized for use in case of war; but as these belong to the great Powers, they do not come within the scope of the present article. Although these minor navies exist, it would seem somewhat problematical if they will continue to do so in the future; more and more, as time goes on, does the power of the purse assert itself in maritime affairs; at sea as well as on shore the wholesale man seems destined to oust or to gobble up the retail dealer; the small man in any walk of life at the present time seems in danger of absolute extinction, and, as with commerce, so it is with armaments. Powers like Spain, Holland, Brazil, or Chili may own men-of-war which are comparatively modern, and consequently useful; but as time goes on the life of warships seems to shorten more and more, and the constructive marvel of a decade ago is hopelessly *declassé* to-day. Estimates for new construction have to be faced by the great Powers in that struggle for existence which is leading them no man knows whither; but so great is the burden, so appallingly does expense mount up nowadays in the building of even moderate-sized cruisers, that it is very doubtful if the minor Powers will be able to face the taxation

necessary for the upkeep of their fleets. It may be that national pride will nerve them for the making of the sacrifice; but even if made, it is hard to see of what value it will be when it is remembered that the struggle is unceasing and year by year more costly; the common sense of the matter would appear to be that, as that nation is said to be happy which has no history, it would be better to give up attempting to make it by futile expenditure upon naval armaments.—*Engineering.*

SUPERIOR SPEED NOT ESSENTIAL TO NAVAL SUPREMACY.—If one side is determined to fight and the other is not willing, the latter must withdraw either into port or to some other area. Both cannot remain in the same waters without fighting. The larger the forces and the smaller the area the greater will be the difficulty to avoid battle. So often has this been found to be the case that it amounts to a truism, but to emphasize the point we may ask whether two large opposing fleets could remain long in the North Sea without coming into collision if one was bent on fighting? In the days of sail they came quickly into contact in such a narrow field, and under modern conditions will have as good a chance of doing so in larger areas, since steam and wireless telegraphy have enlarged the sphere of action on both sides. No designed superiority of speed in the ships of the weaker can do more than delay the meeting, because experience shows that sooner or later either failure of speed or some unforeseen circumstance brings it about. The larger the squadron the greater is the chance that speed may fail; its precarious nature when ships are pressed and the wide margin on service between ships nominally the same is well known. If the weaker cannot remain in the area when his ships are concentrated, still less can he do so if they are spread. Such a policy only facilitates the enemy's work, as he can more easily pick up detached ships. In fact, to concentrate power in capital ships and then to disperse them is a contradictory policy impossible to justify.

A good position is more important than superior speed, and can be used to counterbalance the strategical advantages belonging to the latter. Thus, when Suffren captured Trincomalee in the year 1782, he placed himself at Batacoloa, less than one day's sail from his objective, while Hughes was at Madras, fourteen days' distant. No conceivable superiority of speed could have saved the place. Again, as Captain Mahan has clearly shown in the important paper recently contributed to the *Proceedings of the U. S. Naval Institute*, Togo's position at Masampho would have enabled him to intercept Rodjesvenski, irrespective of the route taken to Vladivostok, even if the Russian fleet had been faster than the Japanese.

When examined by the light of the preceding remarks, the naval maneuvers of the current year will be found to be instructive. It will be remembered that the forces were very unequal, the Red (English) being more than twice as strong as the Blue (the enemy). The former had 41 capital ships and 20 cruisers, or 61 in all, of which rather less than one-third were based on Gibraltar and the remainder on Falmouth or other English ports; the latter had 18 capital ships and 9 cruisers, or 27 in all, at Berehaven or other Irish ports. The nominal area of the operations was included between the parallels of 30 degrees N. and 60 degrees N., and between the meridians of 20 degrees W. and 10 degrees E. It measured about 1800 miles in length, and varied from 1000 to 500 miles in breadth. The real area was much smaller, as it was the trade-route from the Chops of the Channel to Gibraltar, and measured not more than 900 miles in length by, perhaps, 350 miles in width. Blue's aim was to tempt Red to use his force improperly under the pressure of public opinion. With this end in view he was to attack the trade in a strictly limited area, completely commanded by a greatly superior force. Red knew this, and, as all ships were to put to sea at noon on June 24, he was not troubled with Nelson's doubts during the Trafalgar campaign. Blue spread his ships in the limited area. As was to be expected, he was beaten in detail and compelled to fly for safety to his base in the North Sea with a mere

remnant of his force. In time of peace it is difficult to conceive the triumphant and exultant feeling which the news of such a victory would raise in this country. What might have been expected to happen to Ganteaume's fleet in 1805 if Napoleon had ordered him to put to sea from Brest and to attack the trade in the same waters, if the French admiral had done so and had spread his ships, if Nelson at Gibraltar and Cornwallis in Torbay had known his mission and the time of his sailing? Napoleon would never have had any doubt. He was too great a master of the art of war to spread an inferior force within striking distance of a greatly superior fleet. The maneuvers this year certainly show that in the future, as in the past, fleets will be composed of ships varying in speed, but they do not prove that superior speed has any particular strategical value, unless it is an advantage to have some ships able to run away. They appear rather to point to the disastrous influence of wrong strategical conceptions, and to the imperative necessity of a closer study of war conditions.

We are now in a position to judge whether superior speed is of such value in a capital ship that other qualities should be sacrificed in part to obtain it. We have shown that superior speed is only one of several factors which contribute to success in war. In tactics it is less important than tactical skill, and it gives a very limited control over the range. In strategy it is discounted by the demands of enduring mobility, by the conditions of war, and by the strategical ability of the admiral. In all cases its uncertainty is such that reliance cannot be placed upon it. Our conclusion is that in designing a capital ship an increase in speed is right if it results from a natural growth, as already explained, but that otherwise it is wrong.—From "The Speed of the Capital Ship," in *Blackwood's Magazine* for October.

THE GIBRALTAR OF THE CHANNEL.—One result of the recent naval maneuvers has been to draw attention to the gradual transformation which Dover harbor is undergoing in the progress it is making towards becoming a national harbor. The old Cinque port has been a center of military activity from time immemorial, and the barracks on the Western Heights still boasts of the carefully preserved foundations of what was once a chapel of the Knights Templar, wherein King John is believed to have done homage for his crown to the Papal Legate. Hitherto, however, Dover has been chiefly known to fame as the "stepping-off" place for the Continent, and also for the undying advertisement given to it in the pages of Shakespeare. But the "old order changeth," and from a Shakesperian asset Dover is on the eve of developing into a very important national one, and assuming the *rôle*, for which nature intended it, of the Gibraltar of the Channel.

For nine years Dover has been in the throes of an engineering activity. Armies of navvies, engineers, divers, and mechanics of all kinds, have been working night and day in constructing the immense arms which run out into the sea, embracing a world of waters which are destined not only as an area for the great national harbor, but also to provide room for our future naval base. For nine years has this great engineering feat been steadily progressing, and in something less than three years from now a harbor and naval base will be given to the British nation which will be the glory of the world. Already the Red Star liners and many of the Hamburg-American boats make Dover their port of call, but not until the magnificent harbor passes out of the contractors' hands will its great importance to the nation as a naval base, and as a harbor for the great ocean traffic, be made manifest.

These have been obtained, in the first place, by building an eastern arm, which runs from the foot of the cliffs below the old convict prison, to a distance of over three thousand feet out into the sea, in an encircling direction towards the Admiralty Pier, from which another arm has been

projected about two thousand feet in length, inclining in the direction of the eastern arm. Between these arms, and situated under a mile from the shore, is being erected a monster breakwater, some four thousand feet in length, and this, combined with the two arms, eastern and western, form an encircling protection which encloses a water area of about seven hundred acres, space sufficient to provide shelter for a fleet of battleships, with their attendant auxiliary crafts of gunboats, destroyers, torpedo-boats, etc. As this huge breakwater is still in the hands of the workmen, it is necessarily delaying the announcement to the nation that its unparalleled national harbor is open to the world.

There are points about the new harbor which will conduce towards making it the most important of all our naval bases. In the first place, besides being the largest created harbor in the universe, it will be absolutely torpedo-proof, and in this it would, in the event of hostilities with another great Power arising, give us advantages of an unrivalled nature, both from an offensive as well as a defensive point of view. The fortresses which command the harbor, from the Castle and the Western Heights, are thoroughly capable of repelling any attack, while the comparatively narrow stretch of water which separates us, at this point, from the French coast, would enable our torpedo-boats to frequently run across for offensive purposes, and get back to the protection of the harbor, in an incredible short space of time. Happily our friendship with France, strengthened as it has been by recent events, leaves no room for the formation of any such designs, but that such opportunities will be within our grasp may not be without its effect in determining the European policy of the future, and in any case it will undoubtedly strengthen our position and lend weight to our influence, in the great Council of Nations. In spite of all that has been alleged against us by those who have watched with secret jealousy our growth as a great naval and military Power, we are nevertheless a peace-loving people, and in aiming at thoroughness in the matter of our national defences, we are actuated rather by a desire to prevent that peace from being broken by less scrupulous nations, rather than with an intention of adding in any way to our national aggrandizement.

Dover's national harbor will cost this country above five million pounds sterling, but it will bring increasing prosperity to it under cover of increased security. We shall, doubtless, hear less talk about the probabilities of invasion, and, in a way, it will therefore prove a contributing means towards curing the existing mania for conscription. But apart from all other considerations, our navy will benefit enormously in the unique facilities afforded to it of training in a sphere of the English Channel which, in all probability, will be the scene of the great naval engagements of the future, which, prophets tell us, must inevitably take place some day between the rival fleets of Great Britain and an aggressive great Power. Far be it from us to encourage the prospect of such a conflict, but if it ever takes place it will find us with a navy fully capable of giving a good account of itself, while the name of Dover will be found figuring among the factors which have combined to frustrate the invader, and aid our fleet in adding one more to the great and gorious naval victories of the past.

The day that Dover becomes the Gibraltar of the Channel will mark a new era in the history, not only of the ancient port itself, but of the nation at large. With perfect command over the watery streak which separates us from the Continent, it will add to our supremacy at sea, and virtually make the duties of our first line of defence less onerous than they are at present. The prospect is comforting, and its accomplishment will bring much gratification to the people of these islands. It was Sir Walter Raleigh who first pointed out the great strategical value of Dover as having no equal in its natural situation as a source of offence or defence, and it is the wisdom crystallized in his few pithy words on the subject which has now come to maturity, and resulted in benefiting the country by the

addition of a magnificent harbor, a strong naval base, and a most powerful fortress. No better record of work could an Admiralty hand down to posterity.—*United Service Gazette.*

A REVIEW OF JANE'S HERESIES OF SEA POWER.—Mr. Jane has saddled this sturdy blue quarto with a title of a curiously questionable shape. "Heresies of Sea Power." What, exactly, does it mean? Heresy is one thing—and a very elusive thing, too, since it can only be seen as such from one point of view, and disappears entirely when that standpoint is changed—and Sea Power is another; but, grammatically speaking, you can no more have a heresy of sea power than heresies of a torpedo, or of gravitation, or of the use of the globes. Heresies as to the influence of sea power, then, does Mr. Jane mean, or heresies regarding its principles? But who in this case is the heretic? Mr. Jane himself, or some of his predecessors in the field of naval history? A glance at the preface to some extent loosens the tangle. "Though it seems to be all that its title can imply," we read, the book "has not been produced with a view of casting doubt upon the labors of great men who have made a special study of naval history, but only in order to suggest the possibility of some great principle underlying all naval history, as capable of reinforcing theories of sea power as of destroying them." Mr. Jane, then, is the self-styled heretic, but only, it seems, a very mild one. After reading his introduction, you gather that a fully expanded sub-title might read: "Reflections—not quite orthodox—as to the relative magnitude of the influence of sea power, together with doubts—seemingly somewhat heretical—as to the permanent applicability of any accepted theories whatsoever, deduced from history in regard to it." Two general conceptions, submits Mr. Jane, are accepted by the majority of people as dogmas. The first, to put it broadly, is to the effect that who rules the sea rules the land; the second is that "the possession of a navy of tried skill, power, and general efficiency assures the certainty of victory." That being so, the purpose of his book is to inquire whether there be not sufficient alloy in the metal of these propositions to make whole-hearted trust in them as eternal principles undesirable.

Having thus cleared the ground, it is allowable to ask whether the above "dogmas" have ever really been so authoritatively and uncompromisingly set forth as to raise Mr. Jane's proposed modification to the rank of a heresy at all. According to the book before us, their initiation is attributable to Captain T. Mahan, and their exaggeration to "his imitators and disciples." Since these latter are unnamed they may be disregarded here, but it may be well to re-examine the scope and intention of Captain Mahan's now famous treatise upon "The Influence of Sea Power upon History," since Mr. Jane tends, we think, to misrepresent it.

Is sea power, he says, a peculiar and predominant factor as, to a certain extent it is claimed to be by Captain Mahan?

We have carefully re-read Captain Mahan's preface and introduction, and we cannot anywhere find him falling into the error of unduly magnifying the importance of his subject. His purpose was to raise to its proper dimensions a hitherto neglected side of military history, to reinforce the general proposition that the use and control of the sea has been a great factor in the history of the world by a detailed survey of operations by sea, big and little, during the sailing-ship period lying between 1660-1783. He relied, in fact, upon a numerous collection of illustrative special incidents, and in so doing filled up a big gap hitherto bridged by the vaguest of general observations. In such a book the sea is inevitably ever in the foreground, but the perspective is always admirably preserved, and the relation and interdependence upon each other of sea and land operations is constantly emphasized without undue magnification of either of the two great branches of military history. But "as the study of the military history of the past is essential to correct ideas, so will the study

of the sea history of the past be found instructive by its illustration of the great principles of maritime war."

Now, if Mr. Jane is anywhere "heretical" it is with regard to these general principles. He finds general principles, set adrift upon the unstable medium of the sea, as independable as the color of a chameleon, as elusive as an active rabbit near his burrow. How are you to generalize, for instance, as to the immunity of a fleet anchored in a protected bay? Nelson at Aboukir shattered those theories, yet once, at Algeciras, four French ships lying in a bay handsomely beat Sir James Saumarez with six, while at Navarino the bay secured the Turks no safety. Again, at Actium, heavier and more numerous galleys were annihilated by smaller and fewer ships; at Lepanto lighter vessels succumbed, in their turn, to the monster galleases of Venice. Does history then teach anything save that the impossible may occur? In asking that question Mr. Jane often loses sight, we think, of that distinction between principle and precedent upon which Captain Mahan has laid so just an emphasis.

"A precedent," he says, "is different from, and less valuable than, a principle. The former may be originally faulty, or may cease to apply through change of circumstances; the latter has its root in the essential nature of things, and, however various its application as conditions change, remains a standard to which action must conform to attain success."

And again in illustration:

"The particular tactical combination—at the Nile—depended upon a condition now passed away, which was the inability of the lee ships of a fleet at anchor to come to the help of the weather ones before the latter were destroyed; but the principles which underlay the combination, namely, to choose that part of that enemy's order which can least easily be helped, and to attack it with superior forces, has not passed away."

If that truth and that illustration be kept in view, how shall we impugn the broad veracity of the general proposition that "the battles of the past succeeded or failed according as they were fought in conformity with the principles of war."

Let us turn, however, from the contemplation of sea power in action to the question of the determining influence of sea power itself. The two questions, of course, are closely intertwined; for if the principles governing the control of the sea are as unstable, as Mr. Jane fears, the possession of the strongest fleet in the world may well be the most anxious of military assets. A third of his book is accordingly devoted to a consideration of "Seven Great Naval Wars," in which "accepted theories of sea power were either actually or apparently ignored by the victors." In their order they are the Peloponnesian War, the First and Second Punic Wars, Actium, Lepanto, the Spanish Armada, and the Russo-Japanese War. We will, however, first take the Second Punic War, since Captain Mahan has definitely committed himself to the opinion that the Roman control of the water forced Hannibal to invade Italy by land, and remained throughout the struggle a powerful item in the list of determining factors—not, it should be noticed, an exclusively determining influence. With regard to Hannibal's march, Mr. Jane offers the quite reasonable suggestion that it was deliberate, not necessitudinous, and that Carthage definitely staked her fortunes upon a struggle by land. But if this be so, does not the spectacle of a great sea-faring nation athirst for revenge against a foe who had decisively defeated it upon its own element in a former war seeking that revenge on land, afford strong presumptive evidence that Rome still retained the control of the seas which she had wrested from Carthage? Mr. Jane will not have it so. He holds that, if anything, Carthage was the stronger on the seas in the second Punic War, and that Scipio's final invasion was successful in the teeth of sea strength which should have, according to accepted theories, finally overwhelmed him. But the truth is that the maritime history of the final stages of the war are shrouded in mystery, and he fails entirely to prove

his pair of paradoxes to the effect that: (1) In the first Punic War Rome, having sea power, invaded Africa and met disaster; (2) in the second she had probably not got the sea power. She invaded and succeeded completely.

The first of these "salient facts" seems to us, frankly, absurd. The disaster to Regulus had nothing to do with the sea—was even, indeed, to quote Mr. Jane, "a matter of the purest luck." The influence of the sea appears in his previous defeat of the enemy's fleet, which rendered that invasion possible, and the whole struggle teems with similar instances. The lesson of the war lies, of course, in the fact that ingenuity, energy, and grim determination finally prevailed against accomplished seamanship, but in that daring capture of sea predominance there was nothing running counter to the general bulk of received theory as to its influence. Mr. Jane's treatment of the Peloponnesian War is indeed of more value to his thesis, as showing how unexpectedly a people's control of the sea may pass from them without such overwhelming assets in the enemy's hands as those which enabled Rome to crush Carthage. But even here no paradoxes emerge from a careful study of Athenian sea fights. The loss of the fine Athenian fleets in the fatal harbor of Syracuse was really the always possible climax to the Athenian desertion of a sound for an unsound policy, and even then the single victory at Cyzicus, three years later, gave Alcibiades a foolishly neglected opportunity to make peace upon honorable terms.

On the whole, by the time that the unbiassed reader has digested the last of Mr. Jane's "paradoxes," he is not unlikely to come to the conclusion that in keeping his eye upon the list of victors who have ignored accepted theories he has forgotten to notice that the vanquished have ignored them far more frequently. If you suffer a fine fleet to be hermetically sealed in a harbor—as the Athenians did at Syracuse—you are courting most unorthodox disaster. You should not again, be caught napping, as Russia was in the war with Japan, or as Carthage was at the beginning of her duel with Rome. If you are, and your enemy secures an advantage, it is sheer throwing of stones from glass houses to accuse him of breaking rules.

But it is high time to examine that potent underlying principle in which Mr. Jane finds the eternal verity, the sole secret of success in the struggle to control the seas. It is no less a thing than "Fitness to Win"—"Fitness to Win." We have no desire whatever to linger over the platitude involved. This fitness is defined as "neither ships nor skill at handling them, neither great leaders nor willing obedience, but the sum of the sentiment of each individual combatant"—sentiment being here interpreted as a very keen desire to kill the enemy in the day of battle." The definition, at least, contains a truth. It embraces all that is implied in Nelson's working formula to "hate a Frenchman like the Devil"; or in Hannibal's deadly oath to loathe and ruin Rome; all the intensity of the slaughterous Japanese attack, all the self-sacrifice and endurance which help a country, big or little, in the day of its need. No one will deny that time and again in sea history the potential energy of the victors has been such that they would probably have won had they accepted the ships and the tactical dispositions of their enemy. But to recognize this is by no means to admit that "waste paper is made thereby of all strategy and tactics that have led to victory in he past." Fitness to win, or potential energy, or whatever one likes to call it, is a powerful coefficient of many factors that make for victory, but to disdain those factors as "merely embroidery" is to diminish the value of a really useful and interesting book. Stripped of its exaggeration, this so-called "heresy" is little more than a supplementary rider; or, perhaps, it might be re-labelled on the naval shelf as "Mr. Jane's Amendment."—*The Engineer.*

BOOK NOTICES

"Suggestions to Military Riflemen." By Lieut. Townsend Whelan, U. S. Army.

Lieut. Whelan, who has been the coach for the U. S. Army Infantry Rifle Team for the past two years, has given in this book the most concise and practical treatise on military rifle shooting produced in this country. From its first chapter on "The selection of an accurate rifle," to its last, "The rifleman on the battlefield," it teems with points invaluable to the man behind the rifle. To all officers and instructors in rifle firing, and especially to those organizing and developing rifle teams (either as members of the team or as team coaches) this book will be of great assistance. In fact, even the most expert shots will find valuable hints in it, while those beginning to shoot, or to develop shooting, will find it a perfect mine of information.

(Franklin Hudson Publishing Co., Kansas City, Mo. Price, $1.10.)

"Position-Line Star Tables" is the title of a very useful book of about 100 pages, by H. B. Goodwin, R. N., and issued by J. D. Potter, 145, Minories E. London, price 5 shillings. Briefly stated, it consists of tables for fixing a ship's position from observations of certain stars near the meridian in connection with observations of certain other stars near the prime vertical, or at position of maximum azimuth, without logarithmic calculation; it contains examples illustrative of the method, and deductions explaining the theory on which the tables are based. The tables for the "reduction to the meridian" are identical with those issued several years ago by the same author, but the remaining ones are entirely new in conception as well as application, and are intended to effect, when longitude is sought from observation near the P. V., or at maximum azimuth, a saving of time and labor, similar to what is now accomplished for observations near the meridian by the "reduction to meridian" tables.

Table I, in its various parts, gives the approximate siderial time at which certain selected stars will cross the P. V., will be at position of maximum azimuth in cases where the declination of star is greater than the latitude and of the same name, and also the times they will transit the upper branch of the meridian.

Table II tabulates for the same stars, in the given latitudes, the hour angle and zenith distance when on the P. V., and the seconds of time for a change of one degree of zenith distance, to be used in finding the H. A. corresponding to a given zenith distance observed within certain limits of the P. V. The same table gives "the change of zenith distance per minute of time" to be used when seeking the zenith distance corresponding to a

given H. A., as when applying the methods of "The New Navigation"; under such circumstances, these tables are especially valuable.

Table III gives, for the same stars, corresponding elements for observations at maximum azimuth.

Table IV furnishes the "reduction to the meridian."

Table V expresses minutes and seconds of arc as decimals of a degree, and seconds of time as decimals of a minute of time.

This new method in nautical astronomy is fully explained in an article by Mr. Goodwin in this number of the PROCEEDINGS OF THE INSTITUTE; the reader is also referred to Vol. XXXI, No. 4, for preliminary remarks by the author on the same method. W. C. P. M.

The Franklin Hudson Publishing Co., of Kansas City, Mo., has just issued one of the most important books for the use of the army officers that has been printed. It is a new translation by Major Charles H. Barth, Twelfth Infantry of the Baron von Griepenkerl's "Letters on Applied Tactics," in which Major Barth has introduced the United States organization, together with the English scales of miles and yards. This book contains a large number of problems on field maneuvers, together with discussion of same, and will henceforth be used by student officers in the Ft. Leavenworth Service Schools in place of the English translation used heretofore.

The book costs $2.00 and may be obtained from the Secretary of the U. S. Army Staff College, Ft. Leavenworth, Kans.

"A Text-Book of Constitutional Law." By Edwin G. Davis, First Lieut. Artillery Corps, U. S. Army, West Point, N. Y.

This is a manual of less than 300 pages. The author's experience at West Point has enabled him to make a text-book, which strikes the golden mean, between a profound treatise for use by candidates for the Bar, and those Civic Manuals, of which there are many before the public to-day, that simplify by question and answer, in a diluted sort of way, the principles which lie at the foundation of the Government.

Decisions in some 200 cases are cited in confirmation of the author's commentary; thus making it a valuable book of reference. The volume has for appendices, the following:

The Declaration of Independence; The Articles of Confederation; Resolutions and Letter Transmitted to Congress by the Federal Convention; and Washington's Farewell Address.

It has also a series of questions and answers upon the text, which the author calls "Recreations," these are helpful to the student in review, and of use to the instructor in the class room. The volume has many merits and will undoubtedly meet the favor which it deserves.

Franklin Hudson Publishing Co., Kansas City, Mo.

LIST OF PRIZE ESSAYS.

1879.

Naval Education. Prize Essay, 1879. By Lieut.-Com. A. D. Brown, U. S. N.

NAVAL EDUCATION. First Honorable Mention. By Lieut.-Com. C. F. Goodrich, U. S. N.

NAVAL EDUCATION. Second Honorable Mention. By Commander A. T. Mahan, U. S. N.

1880.

"The Naval Policy of the United States." Prize Essay, 1880. By Lieutenant Charles Belknap, U. S. N.

1881.

The Type of (I) Armored Vessel, (II) Cruiser best suited to the Present Needs of the United States. Prize Essay, 1881. By Lieutenant E. W. Very, U. S. N.

SECOND PRIZE ESSAY, 1881. By Lieutenant Seaton Schroeder, U. S. N.

1882.

Our Merchant Marine: The Causes of its Decline and the Means to be taken for its Revival. "Nil clarius aquis." Prize Essay, 1882. By Lieutenant J. D. J. Kelley, U. S. N.

"MAIS IL FAUT CULTIVER NOTRE JARDIN." Honorable Mention. By Master C. G. Calkins, U. S. N.

"SPERO MELIORA." Honorable Mention. By Lieut.-Com. F. F. Chadwick, U. S. N.

"CAUSA LATET: VIS EST NOTISSIMA." Honorable Mention. By Lieutenant R. Wainwright, U. S. N.

1883.

How may the Sphere of Usefulness of Naval Officers be extended in Time of Peace with Advantage to the Country and the Naval Service? "Pour encourager les Autres." Prize Essay, 1883. By Lieutenant Carlos G. Calkins, U. S. N.

"SEMPER PARATUS." First Honorable Mention. By Commander N. H. Farquhar, U. S. N.

"CUILIBET IN ARTE SUA CREDENDUM EST." Second Honorable Mention. By Captain A. P. Cooke, U. S. N.

1884.

The Reconstruction and Increase of the Navy. Prize Essay, 1884. By Ensign W. I. Chambers, U. S. N.

1885.

Inducements for Retaining Trained Seamen in the Navy, and Best System of Rewards for Long and Faithful Service. Prize Essay, 1885. By Commander N. H. Farquhar, U. S. N.

1886.

What Changes in Organization and Drill are Necessary to Sail and Fight Effectively Our Warships of Latest Type? "Scire quod nescias." Prize Essay, 1886. By Lieutenant Carlos G. Calkins, U. S. N.

THE RESULT OF ALL NAVAL ADMINISTRATION AND EFFORTS FINDS ITS EXPRESSION IN GOOD ORGANIZATION AND THOROUGH DRILL ON BOARD OF SUITABLE SHIPS. Honorable Mention. By Ensign W. L. Rodgers, U. S. N.

1887.

The Naval Brigade: its Organization, Equipment and Tactics. "In hoc signo vinces." Prize Essay, 1887. By Lieutenant C. T. Hutchins.

1888.

Torpedoes. Prize Essay, 1888. By Lieut.-Com. W. W. Reisinger, U.S.N.

1891.

The Enlistment, Training and Organization of Crews for our Ships of War. Prize Essay, 1891. By Ensign A. P. Niblack, U.S.N.

DISPOSITION AND EMPLOYMENT OF THE FLEET: SHIP AND SQUADRON DRILL. Honorable Mention, 1891. By Lieutenant R. C. Smith, U.S.N.

1892.

Torpedo-boats: their Organization and Conduct. Prize Essay, 1892. By Wm. Laird Clowes.

1894.

The U.S.S. Vesuvius, with Special Reference to her Pneumatic Battery. Prize Essay, 1894. By Lieut.-Com. Seaton Schroeder, U.S.N.

NAVAL REFORM. Honorable Mention, 1894. By Passed Assistant Engineer F. M. Bennett, U.S.N.

1895.

Tactical Problems in Naval Warfare. Prize Essay, 1895. By Lieut.-Com. Richard Wainwright, U.S.N.

A SUMMARY OF THE SITUATION AND OUTLOOK IN EUROPE. An Introduction to the Study of Coming War. Honorable Mention, 1895. By Richmond Pearson Hobson, Assistant Naval Constructor, U.S.N.

SUGGESTIONS FOR INCREASING THE EFFICIENCY OF OUR NEW SHIPS. Honorable Mention, 1895. By Naval Constructor Wm. J. Baxter, U.S.N.

THE BATTLE OF THE YALU. Honorable Mention, 1895. By Ensign Frank Marble, U.S.N.

1896.

The Tactics of Ships in the Line of Battle. Prize Essay, 1896. By Lieutenant A. P. Niblack, U.S.N.

THE ORGANIZATION, TRAINING AND DISCIPLINE OF THE NAVY PERSONNEL AS VIEWED FROM THE SHIP. Honorable Mention, 1896. By Lieutenant Wm. F. Fullam, U.S.N.

NAVAL APPRENTICES, INDUCEMENTS, ENLISTING AND TRAINING. The Seaman Branch of the Navy. Honorable Mention, 1896. By Ensign Ryland D. Tisdale, U.S.N.

THE COMPOSITION OF THE FLEET. Honorable Mention, 1896. By Lieutenant John M. Ellicott, U.S.N.

1897.

Torpedo-boat Policy. Prize Essay, 1897. By Lieutenant R. C. Smith, U.S.N.

A PROPOSED UNIFORM COURSE OF INSTRUCTION FOR THE NAVAL MILITIA. Honorable Mention, 1897. By H. G. Dohrman, Associate Member, U.S.N.I.

TORPEDOES IN EXERCISE AND BATTLE. Honorable Mention, 1897. By Lieutenant J. M. Ellicott, U.S.N.

1898.

Esprit de Corps: A Tract for the Times. Prize Essay, 1898. By Captain Caspar Frederick Goodrich, U.S.N.

OUR NAVAL POWER. Honorable Mention, 1898. By Lieut.-Com. Richard Wainwright, U.S.N.

TARGET PRACTICE AND THE TRAINING OF GUN CAPTAINS. Honorable Mention, 1898. By Ensign R. H. Jackson, U.S.N.

1900.

Torpedo Craft: Types and Employment. Prize Essay, 1900. By Lieutenant R. H. Jackson, U.S.N.

THE AUTOMOBILE TORPEDO AND ITS USES. Honorable Mention, 1900. By Lieutenant L. H. Chandler, U.S.N.

1901.

Naval Administration and Organization. Prize Essay, 1901. By Lieutenant John Hood, U.S.N.

1903.

Gunnery in Our Navy. The Causes of its Inferiority and Their Remedies. Prize Essay, 1903. By Professor Philip R. Alger, U.S.N.

A NAVAL TRAINING POLICY AND SYSTEM. Honorable Mention, 1903. By Lieutenant James H. Reid, U.S.N.

SYSTEMATIC TRAINING OF THE ENLISTED PERSONNEL OF THE NAVY. Honorable Mention, 1903. By Lieutenant C. L. Hussey, U.S.N.

OUR TORPEDO-BOAT FLOTILLA. The Training Needed to Insure its Efficiency. Honorable Mention, 1903. By Lieutenant E. L. Beach, U.S.N.

1904.

The Fleet and its Personnel. Prize Essay, 1904. By Lieutenant S. P. Fullinwider, U. S. N.

A PLEA FOR A HIGHER PHYSICAL, MORAL, AND INTELLECTUAL STANDARD OF THE PERSONNEL FOR THE NAVY. Honorable Mention, 1904. By Medical Inspector Howard E. Ames, U. S. N.

1905.

American Naval Policy. Prize Essay, 1905. By Commander Bradley A. Fiske, U. S. N.

THE DEPARTMENT OF THE NAVY. Honorable Mention, 1905. By Rear-Admiral Stephen B. Luce, U. S. N.

1906.

Promotion by Selection. Prize Essay, 1906. By Commander Hawley O. Rittenhouse, U. S. N.

THE ELEMENTS OF FLEET TACTICS. First Honorable Mention, 1906. By Lieut-Com. A. P. Niblack, U. S. N.

GLEANINGS FROM THE SEA OF JAPAN. Second Honorable Mention, 1906. By Captain Seaton Schroeder, U. S. N.

THE PURCHASE SYSTEM OF THE NAVY. Third Honorable Mention, 1906. By Pay Inspector J. A. Mudd, U. S. N.

NOTICE.

The U. S. Naval Institute was established in 1873, having for its object the advancement of professional and scientific knowledge in the Navy. It now enters upon its thirty-fourth year of existence, trusting as heretofore for its support to the officers and friends of the Navy. The members of the Board of Control cordially invite the co-operation and aid of their brother officers and others interested in the Navy, in furtherance of the aims of the Institute, by the contribution of papers and communications upon subjects of interest to the naval profession, as well as by personal support and influence.

On the subject of membership the Constitution reads as follows:

ARTICLE VII.

Sec. 1. The Institute shall consist of regular, life, honorary, and associate members.

Sec. 2. Officers of the Navy, Marine Corps, and all civil officers attached to the Naval Service, shall be entitled to become regular or life members, without ballot, on payment of dues or fee to the Secretary and Treasurer, or to the Corresponding Secretary of a Branch. Members who resign from the Navy subsequent to joining the Institute will be regarded as belonging to the class described in this Section.

Sec. 3. The Prize Essayist of each year shall be a life member without payment of fee.

Sec. 4. Honorary members shall be selected from distinguished Naval and Military Officers, and from eminent men of learning in civil life. The Secretary of the Navy shall be, *ex officio*, an honorary member. Their number shall not exceed thirty (30). Nominations for honorary members must be favorably reported by the Board of Control, and a vote equal to one-half the number of regular and life members, given by proxy or presence, shall be cast, a majority electing.

Sec. 5. Associate members shall be elected from Officers of the Army Revenue Marine, foreign officers of the Naval and Military professions, and from persons in civil life who may be interested in the purposes of the Institute.

Sec. 6. Those entitled to become associate members may be elected life members, provided that the number not officially connected with the Navy and Marine Corps shall not at any time exceed one hundred (100).

Sec. 7. Associate members and life members, other than those entitled to regular membership, shall be elected as follows: "Nominations shall be made in writing to the Secretary and Treasurer, with the name of the member making them, and such nominations shall be submitted to the Board of Control, and, if their report be favorable, the Secretary and Treasurer shall make known the result at the next meeting of the Institute, and a vote shall then be taken, a majority of votes cast by members present electing."

The Proceedings are published quarterly, and may be obtained by non-members upon application to the Secretary and Treasurer at Annapolis, Md. Inventors of articles connected with the naval profession will be afforded an opportunity of exhibiting and explaining their inventions. A description of such inventions as may be deemed by the Board of Control of use to the service will be published in the Proceedings.

Single copies of the Proceedings, $1.00. Back numbers and complete sets can be obtained by applying to the Secretary and Treasurer, Annapolis, Md.

Annual subscriptions for non-members, $3.50. Annual dues for members and associate members, $3.00. Life members fee, $30.00.

All letters should be addressed to Secretary and Treasurer, U. S. Naval Institute, Annapolis, Md., and all checks, drafts, and money orders should be made payable to his order, without using the name of that officer.

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SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1908.

A prize of two hundred dollars, with a gold medal, and a life-membership in the Institute, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1908. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. If, in the opinion of the Board of Control, the best essay presented is not of sufficient merit to be awarded the prize, it may receive "Honorable Mention" or such other distinction as the Board may decide.

5. In case one or more essays receive "Honorable Mention," the writer of the first of them in order of merit will receive seventy-five dollars and a life-membership in the Institute.

6. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

7. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

8. All essays submitted must be either typewritten or copied in a clear and legible hand.

9. In the event of the prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of the gold medal.

By direction of the Board of Control.

PHILIP R. ALGER,
Professor, U. S. N., Secretary and Treasurer.

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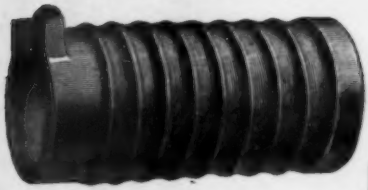

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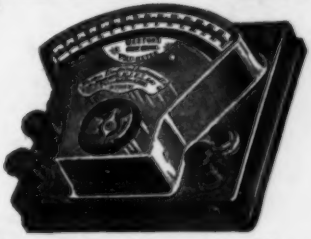

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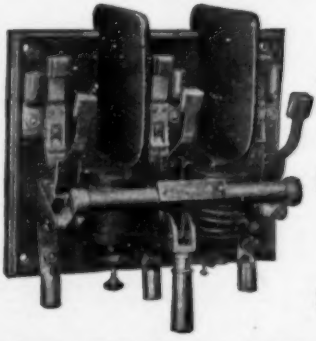

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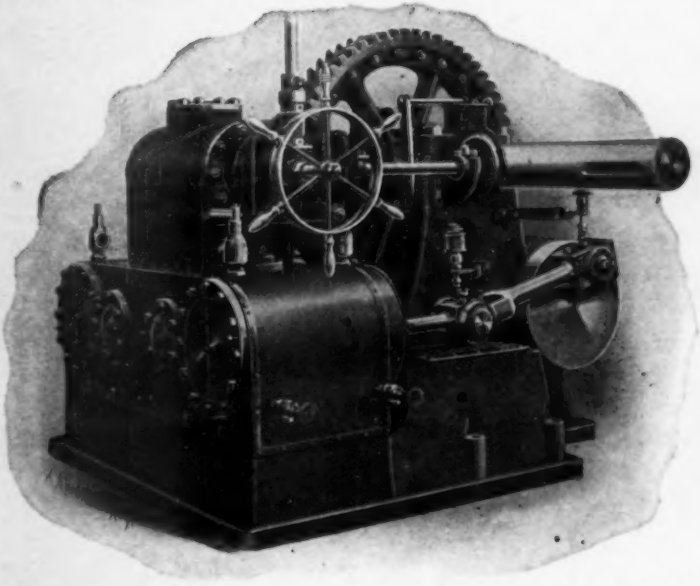

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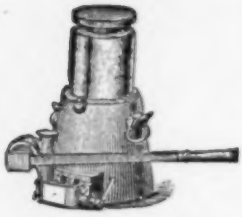

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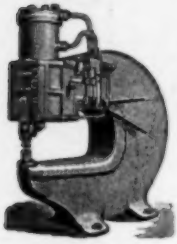

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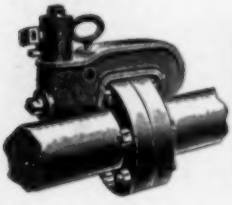

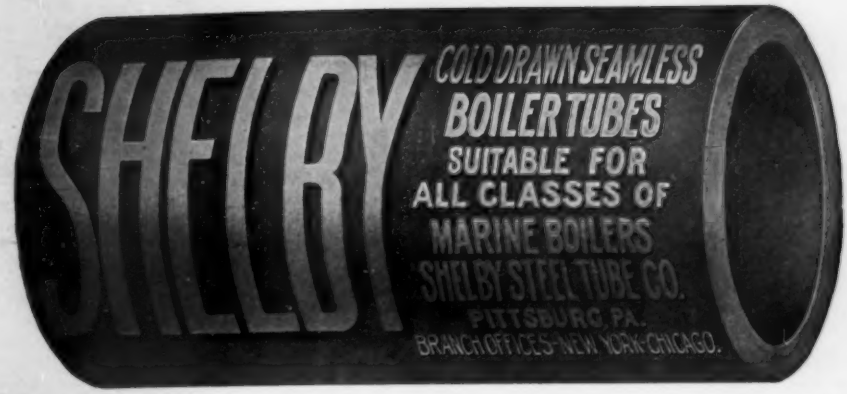

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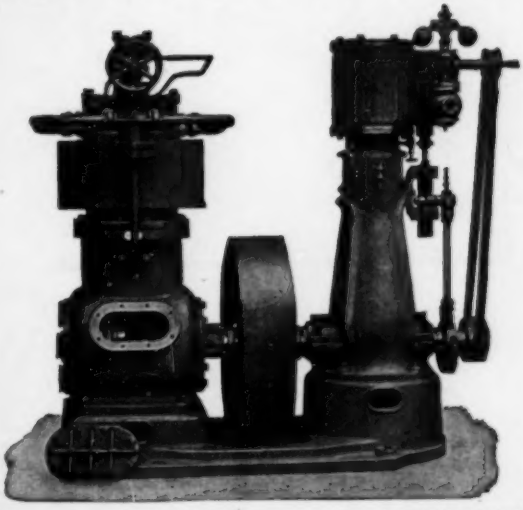

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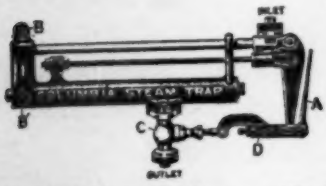

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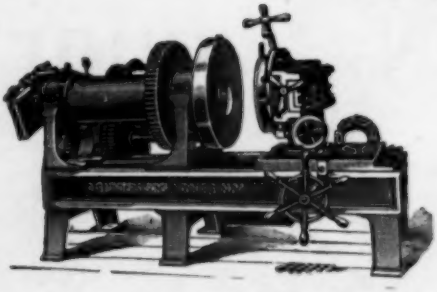

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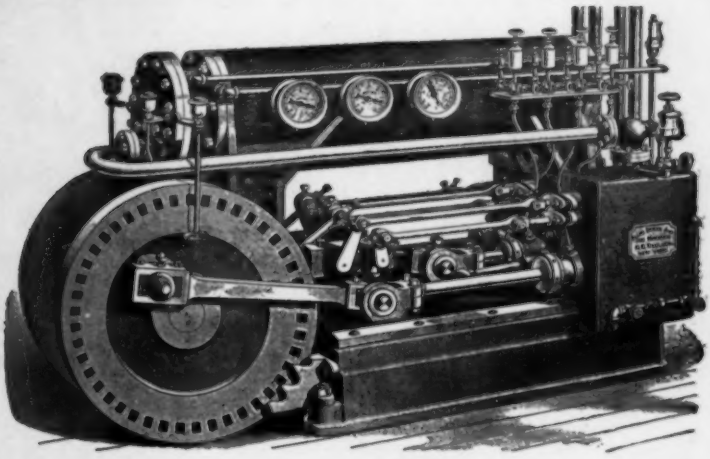

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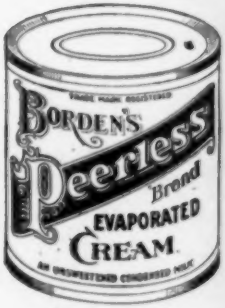

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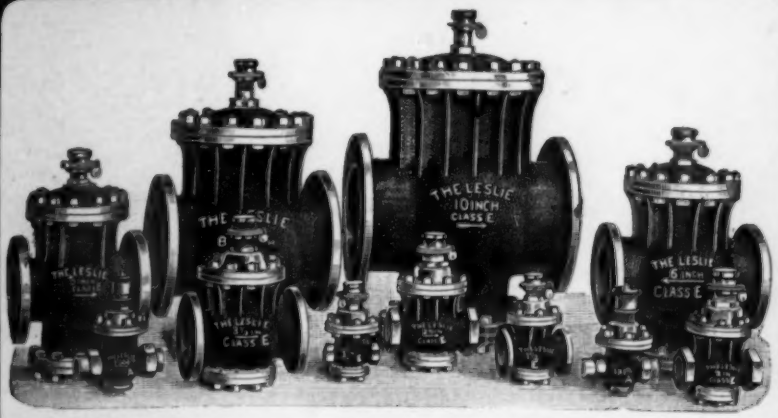

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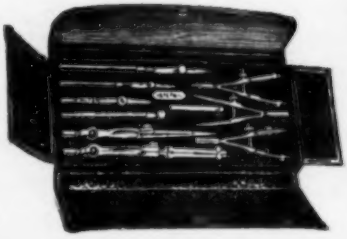

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